THURSDAY, FEBRUARY 25, 1915.

ROMAN BIRDS AND AMERICAN POETS.

The Birds of the Latin Poets. By Prof. E. W. Martin. Pp. 260. (California: Stanford University, 1914.) Price 1.00 dollar.

THIS book is a monument of patient industry redolent rather of the midnight oil than of the woods and fields. It is mainly an anthology of quotations from Latin, American, and English poets. As a serious contribution to our knowledge of birds, whether European or American, it is not of great value, and naturalists will find it disappointing. But scholars will find it useful as a dictionary or concordance of Latin birds, and to American nature-poets it will prove a treasury of their own bird-lore. The preface should be read first, to prepare the reader for its defects, which to our mind are serious. "My single year in Europe," says the author, "occupied largely with the technique of our craft, left scant time for woods, meadows, and riverside. Besides, this is the task of years for a finished expert in the birds of Europe."

Not having the latter qualifications, Prof. Martin is driven to illustrating the birds of Virgil and Ovid by those of America—which is unsatisfactory, to say the least. The species are hopelessly confused, and we are seldom helped to identify them.

"Naturally, in bringing together American and Roman birds, I have attempted no close scientific paralleling of species; I have rather tried to group the birds which have roused similar reactions in the feelings of their poetic observers. Hence Roman nightingales have suggested American mocking-birds and even whip-poor-wills, while larks have been answered by bobolinks and starlings by meadowlarks."

In the lengthy bibliography at the end of the book several British ornithologists are mentioned, but we miss the names of Yarrell and Howard Saunders, and apparently Dresser's monumental "Birds of Europe" has not been used at all.

We must now make some more detailed criticisms. On p. 43 Wordsworth's line, "The tremulous sob of the complaining owl," is quoted under Bubo, the eagle-owl; whereas he is certainly referring to the brown or tawny owl. Nor are we told that he afterwards changed this line into "The sportive outcry of the mocking owl." On p. 68 Tennyson's "many-wintered crow" is the rook, as his next line shows. Why did not Prof. Martin quote it? "Presso gutture," so far from meaning "with clear deep note," means the falsetto love-note of the rook in spring (p. 75). Under Haliæetos (p. 109) no attempt is made to distinguish the sea-eagle from the osprey. The Nisus and Scylla myth is probably simply typical of any hawk that strikes down its prey in the air. Kingsley's magnificent hexameter would have been worth including: "As when an osprey aloft, dark-eye-browed, royally crested."

On p. 118 we are told that "the swallow is an enemy of bees, which they feed (*sic*) to their young." This is true, but some comment is needed. Was Tennyson right when he changed "bee" into "fly" in the well-known line, "The swallow stopt as he hunted the fly"? There is a beautiful swallow legend on p. 121, which we are glad to see. In the note on p. 240 the house-martin's name, *Hirundo urbica*, is applied to the swallow. In spite of his apology in the preface, we find it difficult to forgive Prof. Martin for illustrating our queen of song-birds with the whip-poor-will and mocking-bird. Moreover, it is the reed-warbler, and not the sedge-warbler, which is called the "mock-nightingale" in England (p. 242). But the note on Ruscinia contains much valuable matter, especially Prof. Pierantoni's remarks about the Italian nightingale and the poplar-tree, which is an interesting confirmation of Georgic iv., 511. After quoting four words from Coleridge on p. 131, Prof. Martin hurries on to something inferior and less relevant. Surely this beautiful passage was worth quoting in full:—

> 'Tis the merry nightingale
> That crowds and hurries and precipitates
> With thick fast warble his delicious notes,
> As he were fearful that an April night
> Would be too short for him to utter forth
> His love-chant, and disburthen his full soul
> Of all its music.

There are several quotations from Tennyson, but we miss his "mellow ouzel fluting in the elm"; and his exquisite line on the ring-dove or wood-pigeon is applied to the turtle-dove. Again, his line, "The fire-crowned king of the wrens," is applied to the common wren; and under the same heading (Regulus) we meet with Gilbert White's wood-wren, which is not a wren at all. Milvus is paralleled with not only kite, but also with hawk, falcon, buzzard, and even eagle. On p. 153 we are told that "the note of the bee-eater is like that of wren and swallow." On p. 197 the same quotation from the "Anthologia Latina" appears, with the remark, "The wren's song is like that of the bee-eater and swallow." What this means we must leave our readers to determine.

Strix is illustrated by "the bat and owl inhabit these." We are not sure that Lowell himself would have recognised this illuminating excerpt from his works. Ulula is said to be "the sceech-owl (*sic*) or possibly the barn-owl." We in Eng-

land do not know the difference. Here are three consecutive quotations illustrating "The Spring Migration and Spring Song":—

And new-come birds each morning sing.
(LOWELL.)
Two feathered guests from Alabama, two together.
(WHITMAN.)
And warmed the pinions of the early bird.
(THOREAU.)

We will leave our readers to make their own comments. There are a vast number of quotations like these, which seem to be stirred in at random. We believe Prof. Martin's countrymen have a prejudice against Greek, but in our opinion his book would have gained enormously in interest and value if he had included some Greek quotations, or at least translations of them. For instance, Homer's passage on the nightingale is even finer than Virgil's. (See Odyssey xix., 518.)

But "a detailed study of the birds in the English poets is, perhaps, our most immediate need" (Preface, p. 1). Prof. Martin may be glad to see our own Laureate at his best in "Nightingales":—

Alone, aloud in the raptured ear of men
We pour our dark nocturnal secret; and then,
As night is withdrawn,
From these sweet-springing meads and bursting boughs of May,
Dream, while the innumerable choir of day
Welcome the dawn.

We gladly acknowledge that Prof. Martin has done a great deal of hard spadework which will serve as a foundation for future writers. He has written a modest, honest, and very painstaking book, displaying a German thoroughness which we should like to have seen turned to better account. Many of his American quotations are extremely pretty, and it is a pity that his gold should suffer from contact with so much dross. Work of this kind should be done, as he confesses in his preface, "preferably by a native, on the ground; and it may well be the task of some future Thoreau or Burroughs." T. F. ROYDS.

FACTORY ECONOMICS.

The Modern Factory, Safety, Sanitation, and Welfare. By Dr. G. M. Price. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd, 1914.) Price 17*s.* net.

DR. PRICE has been for some years the Director of the Joint Board of Sanitary Control in the mantle, costume, and blouse industries in the United States, a new experiment in the sanitary control of an industry by organised employers, organised workers, and representatives of the public. He was also director of the investigations of the New York State Factory Commission in 1912 and 1913, and his previous experience as a sanitary inspector and as practitioner in a crowded section of the East End of New York entitles him to speak with authority on the close relation between factory conditions and industrial health. His book is one which should especially commend itself to employers, his clear style and practical knowledge enabling him to dispense with the technical terms which so frequently deter business men from profiting by scientific studies of health conditions.

The chapter on the rise, growth, and influence of the factory is as good as any history of all industries in all countries in all times contained in thirty-eight pages can possibly be. The coincidence of a great increase of population in England with an alleged increase in occupational mortality, both due to the same cause, does not receive either here or anywhere else the attention it deserves.

The rest of the volume has the freshness and originality which only practical knowledge can give. In a short notice it is only possible to direct attention to the wealth of detailed examination of means of improving factory conditions, and to give a few quotations bearing on questions of pressing importance in the United Kingdom.

With reference to underground bakeries and other employment in cellars, Dr. Price concludes: "Cellars cannot be kept clean as other parts of the house, for they are semi-dark, contain most of the plumbing pipes and fixtures, and are, as a rule, the dumping-ground of the whole house. Cellars are also the natural habitation of insects, rodents, etc., and are also in proximity to breeding-places of flies, which are attracted to the foodstuffs" (p. 50).

The desirability of paying attention to beauty in architecture is urged, but rather from the point of view of the community living in the neighbourhood than of the worker. It must be remembered that money spent on front gardens and outsides of factories does not necessarily guarantee even good surroundings for the workers inside.

Fifty-seven pages with twenty-two illustrations are devoted to the causes and prevention of factory fires. The chapter on factory accidents and safety contains 103 pages and eighty-one illustrations. The estimates quoted of accidents in the United States (pp. 133–4) will not bear cross-examination and would be better omitted. The chapter itself is of the highest value. Attention should be paid to the section on accidents due to the physical unfitness of workers: "Not only should there be a routine physical examination of every worker in every establishment before employment, but there should be a periodical examination not less than once in three months, by competent medical men,

of every employee in the establishment, to determine his physical condition and his fitness for his special work" (p. 150).

The subject of light and illumination in factories receives careful treatment: "In Holland the law requires a minimum intensity of 10 bougie-meters (1 foot-candle) to be maintained, and in some special industries, such as sewing, embroidery, knitting, printing, etc., an intensity of 15 bougie-meters (1½ foot-candles) is required" (p. 240).

Employers welfare work is considered, and incidentally "scientific management" is brought under review: "The chief opposition to scientific management in factories comes from the workers themselves, from their representatives, and from those social workers who dispassionately judge this new efficiency movement in industrial production" (p. 303). The example of an English manufacturing firm in employing a dentist to attend to the teeth of their workers is recommended for imitation.

The chapter on "Air Ventilation in Factories" includes forty-five pages and twenty-one illustrations; that on "Industrial Tests and Dusty Trades," an equal number of pages and thirty-seven illustrations. The illustrations in the chapter on "Industrial Poisons, Gases, and Fumes," by showing the intense discomfort of the necessary preventive measures, enable the reader to realise to a small extent the terrible dangers to which the workers in certain industries are exposed.

CACAO AND COCO-NUTS.

(1) *Cocoa.* By Dr. C. J. J. van Hall. Pp. xvi + 515. (London: Macmillan and Co., Ltd., 1914.) Price 14*s.* net.

(2) *The Coco-Nut.* By Prof. E. B. Copeland. Pp. xiv + 212. (London: Macmillan and Co., Ltd., 1914.) Price 10*s.* net.

THESE two volumes form notable additions to the literature of economic botany, and will be welcomed alike by planters and departmental officials. (1) For some years past the cacao planter has been tolerably well provided with useful handbooks, and an extensive and important literature has arisen in regard to special aspects of his industry. Dr. van Hall's task, therefore, has been undertaken with considerable initial advantage, but with a special opportunity of sifting the evidence now available and affording an authoritative summing-up. Few are better qualified for this task than the author, and the present volume unquestionably affords the best available discussion of the principles underlying the successful cultivation of cacao. The arrangement of the book follows established lines. Chapters on the history, chemistry, and botany of *Theobroma Cacao* are succeeded by a discussion of methods of cultivation, fermentation, and preparation for the market, and treatment of pests and diseases; there is, moreover, an admirable account of the varying methods of cultivation and preparation adopted under the varying conditions of the great cacao-growing countries. Throughout the book the usual English rendering, "cocoa," is adopted in preference to "cacao."

Among the most valuable chapters are those dealing with the botanical characteristics of the tree and its cultivation as a crop. The correct understanding of the morphology and physiology of the plant is of the greatest practical importance, and much of the author's convincing treatment of the problems of cacao cultivation rests upon his appreciation of this fact. Planters will turn with interest to the discussion of the perennial questions of "shade" and manures, while the account of the progress made in Java with experimental grafting and budding of selected varieties will be welcomed by West Indians, who were the first to recognise the possibilities of this practice. It would seem, however, that at present Dr. van Hall does not fully share the optimism expressed in certain circles in regard to the *practical* possibilities of this line of work. The author will gain the confidence of planters and others by his respect for the experience of sound, practical men and avoidance of dogmatic assertion: "It is a golden rule that cultural methods must always be entirely dependent on local conditions." The book is well printed and the numerous illustrations are excellent.

(2) Prof. Copeland's well-illustrated book is one of the best accounts of the science and practice of coco-nut culture that has yet appeared. As professor of plant physiology in the College of Agriculture of the University of the Philippines, the author has for some years past been occupied with researches into the physiology of the coco-nut palm, and the present volume is substantially a discussion of the practical aspects of coco-nut growing in the light of the results of his investigations. As main topics the author deals with the physiology of the palm, climate and soil, diseases, selection of seed, field culture, and coco-nut products. His own practical experience has been the basis for his treatment of planting practice, and, in consequence, the book is chiefly concerned with coco-nut planting as carried out in the Philippines. Special value attaches to the chapters on climate, soil, and culture, since, as might be expected, they have been written with full regard to the physiology of the plant, a subject dealt with all too briefly in an excellent and

suggestive section. The importance of selection of seed to meet the varying needs of the different markets for coco-nut products is insisted on in a very interesting chapter.

A pleasing omission from the book is the oft-encountered estimate of "cost of establishing a plantation," and the author explains the absence of statistics of coco-nut production on the grounds of their untrustworthiness. On the other hand, it should have been found possible to include, in the brief chapter on "Coco-nut Products," a reference to the now important trade in "desiccated coco-nut." It is interesting to note that the author follows Cook in regarding the American tropics as the home of the coco-nut palm; that he finds no evidence that salt is necessary for the full development of the plant; and that he discounts the view that sea-shores are the only proper localities for a plantation. S. E. CHANDLER.

MAN AND THE UNIVERSE.

(1) *The Concept of Sin.* By Dr. F. R. Tennant. Pp. iv+281. (Cambridge University Press, 1912.) Price 4*s.* 6*d.* net.

(2) *God and the Universe: a Physical Basis for Religion and Ethics.* By Prof. G. W. de Tunzelmann. Pp. 256. (London: S.P.C.K., 1912.) Price 4*s.*

(3) *The Principia or the First Principles of Natural Things, to which are added the Minor Principia and Summary to the Principia.* By Emanuel Swedenborg. Translated from the Latin by J. R. Rendell and I. Tansley, with an introduction by Isaiah Tansley, and a foreword by Sir William F. Barrett. Vol. i., pp. cv+545; vol. ii., pp. xxi+699. (London: The Swedenborg Society, 1912.)

(4) *Outlines of the History of Psychology.* By Prof. Max Dessoir. Authorised translation by Donald Fisher. Pp. xxix+278. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1912.) Price 7*s.* net.

(1) IN Dr. Tennant's lucid and fair-minded discussion of the meaning of sin particular points might indeed be criticised. But the query in one's mind is rather the general one as to the value of the concept—why has there been a "decay of the sense of sin"? This is dealt with in an appendix, but quite other reasons than those there recognised must, one feels, be faced.

There are two views of the world; as a slough to be crossed or a marsh to be drained. On the first indeed we shall assign ethical value to results "only in so far as these are exponents of the goodness of the will whence they spring." On the second, such things as suffering and ignorance are evil, not merely as "exponents," or in a "quasi-æsthetic" sense (indeed a Kipling may find a pleasing symmetry in the "widow in sleepy Chester" compensated by an expiatory heap of skulls in Cathay). The present war may be due rather to a collective fallacy than to sin; if its miseries would in that case have no interest for ethics—well, so much the worse for ethics. Just as the deadliest false witness is borne in good faith, so man's cruellest inhumanity to man has been done with approving conscience. Conversely Huck Finn, one supposes, sinned in aiding the runaway Jim, as did the Precentor in failing to enlighten the Little Minister's mother.

From this point of view, again, we shall ask first and last, What is feasible, what is modifiable? Now a man's standard of right is indefinitely alterable, but the degree of his conformity to it, his native conscientiousness, may, like his native retentiveness or intelligence, be fixed. So with the race; the standard changes while the deviation of individuals—the moral scatter—remains fairly constant. And in moulding the race of the future we cannot (apart from eugenics) assume the possibility of influence more direct than through the social environment. Further, the goodwill cannot be only formal if we are to avoid the circularities of the will to believe. And just as the "paradox of hedonism" has a psychological as well as a logical meaning, so the constant query "How shall I acquire merit?" though it need not produce the Pharisee, is yet far from that objectivity which is the mark perhaps of genius and surely of the idealist and love. To the mother the child is not an "exponent" of the parental instinct, but an end. Finally, even if life *is* an examination we are only candidates. To divide the sheep from the goats may be God's business; that it cannot be ours is indeed emphasised by Dr. Tennant. He warns us, too, that he writes for theological students rather than social reformers. But that is just it; we are all social reformers.

(2) Dr. Tunzelmann attempts to provide a "physical" demonstration of the existence of God. The mechanical view, or "model," of the universe has had to be supplemented by the energy model, and this, in its turn, fails to explain the initial distribution of energy that it presupposes. There remains only the mind model. That mind does affect the distribution of energy is "proved" by practically assuming interactionism. But even interactionism only refers to the relation of mind and brain, so that the argument would seem at best to suggest that the material universe is, or was, the cortex of Universal Mind. And mind does not will or know its own nervous correlates. Dr. Tunzelmann's argumentation is strangely un-

equal; often strikingly acute it is often as notably weak, *e.g.*, his identification of life and mind. Convincing as a refutation of crude materialism, the book is scarcely so in its more ambitious aims.

(3) Swedenborg's "Principia" suggests again the distinction between the examiner and discoverer points of view. As a candidate Swedenborg would deserve high marks; "nothing can dim the glory of this magnificent dash into the unknown," and it is easy to recognise in him anticipations of modern physical theories. But, alas! we want views which will not merely be consistent with future results, but will bring these nearer. There remains, no doubt, the purely historical interest, but the history of ideas is peculiar inasmuch as what was helpful in the past is preserved in the present, while the errors, though inevitable at the time, were not merely unsatisfactory as "models," but as mental habits had to be painfully unlearnt. Hence to the student of a science its history is apt to be confusing rather than helpful; and this difficulty one cannot but feel in the case of (4) Prof. Dessoir's history, even though the history of psychology is itself psychology, and excellently as the task is done. The translation reads well, but surely "moment" in the sense of "factor" is still somewhat German English?

C. S.

OUR BOOKSHELF.

Artificial Waterways of the World. By A. B. Hepburn. Pp. xi+171. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 5*s.* 6*d.* net.

THIS book, dealing principally with American waterways, also contains a short account of the principal canals of the world, and is well worth the attention of those interested in internal navigation.

The object of the author is stated to be to place before the public the salient facts as to internal artificial navigation in relation to commercial development. The author considers that the use of canals is to supplement and complement, and not to attempt to rival railways.

Canals have not now the same importance in the transport of materials and the development of the resources of England that they have in America, with its enormous area of inland country situated a long distance from the seacoast. In Great Britain there are no fewer than eight first-class ports situated within comparatively short distances from the interior, and there is no large manufacturing town more than eighty miles from the sea-coast.

An interesting account is given of the original construction and subsequent improvements of the Erie Canal, the principal artificial waterway in the United States. This canal connects the country around Lake Erie with the seaport at New York. It was opened for traffic in 1825, and has, from time to time, been enlarged and improved, and is now capable of taking barges 150 ft. long and carrying 240 tons. It is State owned and now toll free. For a quarter of a century it was the greatest transportation line in the country, giving settlers in the west country an outlet for their products. With its connections it is 433 miles in length, and second only to the Great Canal of China among the artificial waterways of the world. Its importance has, however, been considerably diminished, the tonnage carried by this canal being now only about one-twentieth of that carried by the railways.

The British Journal Photographic Almanac, 1915. Edited by G. E. Brown. Pp. 1068. (London: Henry Greenwood and Co., Ltd.) Paper, 1*s.* net; cloth, 2*s.* net.

THIS volume is the fifty-fourth issue of the photographer's most useful companion, and will be found to be up to the usual standard of accuracy and completeness.

Two notable articles of great interest to amateur workers are those of "Modern Methods of Enlarging," by the editor, and "Photography with the Microscope," by Dr. Duncan J. Reid. Both of these deal with the subjects in clear and precise style, and are well illustrated by carefully selected diagrams. The *résumé* of the year's practical work and the section on novelties in apparatus bring the reader right up to date as regards methods and apparatus. The volume embodies as usual the many formulæ and tables needed in the practical man's work and such useful information as particulars of the photographic societies in the British Empire, etc. By no means unimportant is the well-arranged mass of advertisements of the numerous photographic firms in which the announcements of apparatus and materials are of great interest to the practical worker. Complete indices to text and goods advertised make the mass of valuable information included in these 1068 pages readily available.

Heaton's Annual. The Commercial Handbook of Canada and Boards of Trade Register, 1915. Edited by E. Heaton and J. B. Robinson. Pp. 516. (Toronto: Heaton's Agency; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 5*s.*

THE eleventh annual issue of this useful work of reference will be welcomed by all who have commercial or other dealings with Canada. The detailed information is brought together in a form which makes it easily available, and it will prove of assistance to teachers of commercial geography as well as business men. This year, for the first time, an economic bibliography of the Dominion and Provincial Government reports has been added. The general information includes valuable notes on agriculture, technical education, fisheries, mining, and temperature and rainfall among other matters likely to appeal to students of science.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Measurements of Medieval English Femora.

As it was I who suggested to Dr. Lee the illustration of her mathematical work by a consideration of Dr. Parsons's recent paper on the English thigh bone in the *Journal of Anatomy*, and as I am further responsible for emphasising the extraordinary proportion of the sexes reached by him (owing, as I believe, to his fallacious method of sexing), I may, perhaps, be permitted to reply to his letter in NATURE of February 11.

In the first place, I should like to make a general defence of the action of the Biometric School in venturing to deal with what are too often supposed to be purely anatomical matters; I cannot forget that my criticism of another distinguished anatomist some years ago met with the reply, published in your columns, that he had no intention of discussing the matter with one whom he stated had no anatomical training. In a letter to Dr. Lee, Dr. Parsons emphasises the distinction between the man with anatomical knowledge and the person who approaches these problems with scientific training, but is wanting, so he assumes, in observational experience. Nearly twenty-five years ago, when I first entered from the mathematico-statistical side upon the study of craniometry and osteometry, I venture to think that there existed a very general Continental opinion that British work on these subjects was largely the product of dilettanti. The object of the Biometric School was to reverse that judgment, and to show foreigners, that we in England could provide not only measurements, but methods and results, which they would be compelled in self-defence to adopt, extend, and imitate. In the course of that quarter-century many thousands of crania, many hundreds of skeletons have passed through or remained in my Biometric Laboratory. We have had the most generous help of quite a number of highly trained anatomists, and have been compelled to study many anatomical memoirs. Is it likely that we should remain totally ignorant of the physical properties of the material we have had to deal with, or with the views of anatomists with regard to it? Indeed, one of our extreme difficulties has been the "pie-crust" character of many of the bones coming into our hands. Experience, however, has convinced me that sex has very little indeed to do with the destruction of either craniological or osteological material. That depends to some extent on age at death, but chiefly on the *immediate* physical environment during the period before exhumation of the individual skeletons. We are quite familiar with the distressing experience involved in boxloads of bone dust and bone fragments. But in the face of that experience I state that Dr. Parsons's sexing of the Rothwell femora which gives 64 per cent. males and 36 per cent. females is in error, and bears internal evidence of this error.

In the case of the Naqada skeletons which were among the first brought to my laboratory the wastage through the breaking up of material was excessive, the quantity of bone dust and fragments practically equalled the usable material; the centuries of desert exposure, and the long rough sea journey had produced a selection of bones some 6000 years old, which, if Dr. Parsons's views were correct, should have largely influenced the sex proportions. Yet on a sexing based on far surer ground than Dr. Parsons's, namely, on that of the crania and pelvic bones of the skeletons, we found 59 per cent. of the bones were *female* and only 41 per cent. of the bones *male*. Two series of long bones from London plague pits sexed *anatomically* gave only 56 per cent. males and 44 per cent. females, and the selective destruction in this material must have been very great. In this case the mathematical sexing, using the bicondylar width—which I shall show in a forthcoming memoir to be a more trustworthy sexual character than the femoral head—gave only 52 per cent. males and 48 per cent. females. Where we find—as we do find occasionally—a great disproportion in the sexes, and it is not due to archæological causes, *i.e.* battlefield interments, chief or warrior burials, monastic settlements, etc., it results, I believe, from the personal equation involved in much anatomical sexing. I have watched many an anatomist sexing; he may look at numerous points, but he has rarely given them relative *quantitative* weights; he is almost certain to be biassed by his pet sexual character in the living, the shape of the forehead, the bridge of the nose, the nape of the neck; from nasion to basion there is not a single feature of the skull which is not a pet sex-determinant to one man or another. And it is just the same in the far more difficult matter of long-bone sexing. It is the obliquity of the femur with one man, the muscularity with a second, the pilastric diameter with a third, while Dr. Parsons, following Dwight, pins his faith to the femoral head, and having reached results which give an immense male preponderance, explains it by restating the old axiom [1] that female bones cannot stand the wear and tear which male bones may be expected, owing to their stronger constitution, to survive. What if the female bones were by their smaller size likely to be subjected to a lower bending moment relative to their flexural rigidity? But Dr. Parsons's own material answers himself. His missing female bones are not the small but the *large* female bones, precisely those bones which were likely to be treated as male bones on his plan. If anyone with experience of frequency distributions will examine his distribution (on p. 256, *Journal of Anatomy and Physiology*, vol. xlviii.) thev will find, not that the females are abruptly cut off on the *dwarf* side, but that females are abruptly cut off on the *giant* side, and males on the *dwarf* side. Why? Because in transferring Dwight's rule based on the mixed material of American dissecting rooms to an English medieval population, he has not only overlooked the complete difference of race and time, but a still more important point. *Dwight was measuring moist bones with the cartilage attached*—and, if Dr. Parsons meant to apply this rule, he should have subtracted 3 to 4 mm. from Dwight's limiting values before applying them to his own material!

Looking at Dr. Parsons's results on p. 256 I can but conclude that his sexing is based on a fallacy, and the dip he has created in the Rothwell femora between those with 45 and 47 mm. heads—the range of Dwight's supposed doubtful sex—is due to conscious or unconscious selection of his material; out of the great masses of bones available at Rothwell (which should have occupied in measurement of many characters and in their adequate reduction the whole time of a man for four or five years) Dr. Parsons has chosen a small series giving a remarkable dip at Dwight's limits, limits which I venture to suggest have here no application. These

[1] I should like as a lavman to enter a vigorous protest against Dr. Parsons's, an anatomist's, opinion, that female bones disintegrate "for the same reason" as those of children!

and other points will be discussed in our memoir on the London femora now at press. I write at present at this length merely to indicate that in suggesting to Dr. Lee to illustrate her tables on Dr. Parsons's material, I had in view many observational points which Dr. Parsons, like not a few of our English critics, considers we have made no attempt to appreciate—being "mere mathematicians." KARL PEARSON.

Galton Laboratory, University of London.

A Remarkable Dry Fog in the East Indian Archipelago.

THE observations made on Ben Nevis upon the transparency of the air have shown very clearly that with increasing relative humidity the transparency is diminishing, a consequence of the increasing volume of the light-scattering particles, from which it may be concluded that the particles are of hygroscopic character.

The influence of humidity on the size of these particles was obvious in a very striking way in the dense dry fog that towards the end of the dry monsoon of 1914 spread out over the East Indian archipelago, causing much trouble to navigation.

A short description of this phenomenon is given below. The fog had a grey colour, and was most intense in the month of September, and especially in October, and disappeared when the rains fell. In its most typical form it appeared in Sumatra, in the neighbourhood of Ambon and the islands to the south-east.

In Sumatra it was observed to the north as far as Medan (Deli), the Karo plateau near the Toba lake and Tapanoeli, to the south as far as Benkoelen and the highlands of Kerintji. It was not observed in the open ocean outside the Mentawei Islands.

In the morning the sun was not visible before eight o'clock, when it appeared as a dim red disc. Objects in general were barely visible at 500 metres' distance, and on the thickest days invisible within half this distance; the mountains had disappeared entirely from view.

In Ambon the sea was sometimes invisible from the lighthouse, which is situated close to the shore, and 140 metres above the sea. Also in the straits between Sumatra and Borneo, and the west and east coast of Borneo, the fog was very thick, and though in somewhat less degree it was also observed in the northern part of the Strait of Makasser, on the north coast of New Guinea (in these regions, however, it was more or less mixed up with smoke from forest fires, which caused local intensification), on Sumatra's west coast north of Padang and Malakka Strait.

Though in the other parts of the archipelago the transparency of the air was greater, it was not quite clear, on account of the blue haze that is common to the dry season.

A similar phenomenon (described by Dr. van Bemmelen, *Meteorl. Zeitschr.*, August, 1905), perhaps still more intense, was observed in the very dry year 1902; it then extended to the southern part of the China Sea and to the south-east so far as the Tanimber Islands, the region of greatest intensity being about the same as in 1914. It was also reported from the abnormally dry years 1885, 1888, 1891, and 1896. In Karimata Strait it is a common phenomenon.

Now it is very remarkable that the southern boundary of the fog coincides rather closely with a well-defined line, that separates the region of practically no rainfall from that of greater humidity where light rains begin to appear. In 1914 this line ran in the months of September and October over the south-east point of Sumatra, along Billiton and Borneo's south coast, through Makassar Strait, along North Celebes, and south-eastwards along the south coast of New Guinea, Ambon, and the region south-east of it lying as an oasis of light rainfall in the dry region.

From this it is evident that it is the hygroscopic particles that form the blue haze in the south-eastern part of the archipelago, which, entering into moister regions and increasing their radius, give rise to the appearance of the grey fog.

Physical laws fully account for the fact that the fog is a mere intensification of the haze, though the rather fast transition of the light blue haze to the much thicker grey fog gives the impression of a new phenomenon springing into existence.

So long as the particles are much smaller than the wave-length, the intensity of the scattered light in relation to that of the light falling upon it, may be represented by $I=\alpha r^6/R^2\lambda^4$, when r is the radius of the particle, R the distance from the observer, and λ the wave-length. When r is increasing, the ordinary reflection ultimately appears, and $I=\beta r^2/R^2\lambda^0$.

From the method of dimensions may be concluded (conf. Rayleigh, "Theory of Sound," II., p. 152), I being a simple ratio and α and β passing gradually and rather slowly into each other as r increases, that as the exponent (n) of λ is changing from 4 to 0 the exponent (m) of r changes from 6 to 2. Therefore, so long as n is large enough to produce a colouring of the haze, m will cause a very rapid increase of the intensity of the scattered light, which may account for the rather sudden change of the blue haze to the grey fog.

It is not in the first place the greater number of particles that account for the difference between the transparency of the air in the dry and wet season, but their hygroscopic character. On December 23, 1914, when the wet season had already set in, I counted with Aitken's apparatus at Batavia 50,000 particles in 1 cub. cm., the relative humidity being 84 per cent., and no trace of haze was to be seen. However, on the Ardjoeno (at 2500 metres' height) on October 29, towards the end of the dry season, their number was only 1800 in 1 cub. cm., and notwithstanding the humidity was only 40 per cent., the surroundings were enveloped in an intense blue haze. Especially these very hygroscopic particles, when entering moister regions, will be susceptible to a strong increase of volume, and therefore will be the principal producers of the fog.

When we put the question where those highly hygroscopic particles come from that are responsible for the phenomenon described above, it may be remarked that for the greater part they do not form during the short journey of the trade wind over the archipelago. This takes only a few days, whereas the fog appears after many months of excessive drought. Two causes may be mentioned to which they owe their existence, viz., burning processes in Australia, which are also most frequent after long-prolonged droughts; and, secondly, which I take for the greater influence, the formation from the components of the air, ozone, nitrogen, etc., during the slow descending movement in the Australian anti-cyclone, in which the air probably takes several months to reach the layers near the surface of the earth. C. BRAAK.

Batavia, January, 1915.

A Penalty on Research.

IF Sir Wm. Ramsay was refused a rebate of the duty on alcohol I could scarcely expect better treatment. Nevertheless, I should like to add to his protest, and complaint After a correspondence lasting

several weeks and some courtesy showed me by the local authorities I received the bluntest refusal to my request for a small supply of duty-free alcohol at my private laboratory in Cambridge, and this in spite of the fact that owing to an accident I am permanently prevented from leaving my house and availing myself of the duty-free alcohol at the biochemical laboratory of the University. H. ONSLOW.

11 St. James's Square, S.W., February 19.

MANY who, like myself, are privately engaged in biological research, will feel grateful to Sir William Ramsay for having directed attention to the difficulties which are unreasonably put in their way in regard to the supply of alcohol. May I take this opportunity of adding that, for those not connected with some university or museum, the only methylated spirit obtainable is adulterated to make it undrinkable, which also makes it absolutely useless for the operations of the biologist, who is thus driven to incur great expense in the purchase of alcohol. Some time ago I applied to the excise officers here for a licence to be supplied with methylated spirit for use in research work, and I offered to enter into any bond and to comply with any regulations they liked to impose to ensure its safe custody and honest use. After a correspondence extending over nearly three months, this licence was refused. I hope that Sir William Ramsay's letter may receive attention in the proper quarters, and that reasonable facilities may be given for the supply of both alcohol and methylated spirit for the purposes of research.

ARNOLD T. WATSON.

Sheffield, February 22.

Cement for Polarimeter Tubes.

I SHALL be much obliged if any reader of NATURE will suggest a cement suitable for fastening the end discs to polarimeter tubes. The cement I should like to hear of should be capable of withstanding the action of organic liquids at temperatures between 200°–300°. Fusion of the discs to the tubes would, of course, be best, but would be almost certain to introduce strain. There is no great difficulty in working without cement up to about 200°, but beyond the temperature at which rubber melts—and is, therefore, unsuitable for washers—the problem of keeping the liquid in its tube is by no means a simple one. Possibly someone engaged in work making similar demands may be able to assist me. T. S. PATTERSON.

University of Glasgow, February 20.

The Prices of Chemicals.

"J. J.'s" complaint against chemical dealers for unduly raising prices in consequence of the war seems to have been unjustifiable in the case he mentioned, but it would apply in some other cases. A few weeks ago I wrote to several dealers for some racemic acid; one firm, who had a stock of only half an ounce, let me have it at the pre-war price, whilst another, with a larger stock, charged me just double. S. P.

THE MANUFACTURE OF DYESTUFFS.

THE GOVERNMENT'S MODIFIED SCHEME.

THE discussion on the various aspects of the problem of producing in this country an adequate supply of dyestuffs proceeds without intermission. The question has for some time assumed a national aspect and has been the subject of Parliamentary debate or question on at least three occasions. It has also been debated at meetings of the Chambers of Commerce in the chief industrial centres, and people most directly interested have had many opportunities of expressing their opinions at meetings of their various organisations, or at gatherings specially convened for the purpose.

To a great extent the discussions have centred round the adequacy and equity of the commercial proposals involved in the official scheme now before the public. These have received much more general acceptance than those put forward in the first scheme, and it appears probable that the committee has now received promises of support to an amount representing a substantial proportion of the initial capital proposed for the new company.

The members of the committee themselves admit that it is an easy matter to criticise the scheme adversely, and it is obviously impossible to devise a solution of the problem satisfactory to all minds.

If the matter is to be viewed as an ordinary commercial proposition, if questions of free trade or protection are to be taken into account, or if early dividends are to be assured, then any scheme which might be put forward could be shown to be unworthy of support. But whilst criticism on these lines has been plentiful, there has latterly been a rally of support by those taking broader views—a support which has probably been largely induced by a sense of national need, and has certainly been greatly developed by the action of the Government in offering to endow the research work which is essential to the extent of 100,000*l*. This action has engendered a feeling of confidence that the Government will take any further steps which the future may show to be vital to the success of the British dye manufacturing industry.

It is to be hoped that the committee in charge of the scheme will shortly be able to announce the results of its inquiries and that these will show that the great textile trade of the country has responded adequately. In the meantime, the arrangements for carrying out the necessary preliminary chemical work should be proceeded with.

A Mobilisation of Chemists.

Speaking in Bradford on February 8, the present writer advocated immediate action by the Government or the Board of Trade Advisory Committee in the direction of utilising the services of British chemists. There is on one hand a large amount of chemical work to be done before the industry can be greatly developed, and on the other, there is a great number of well-staffed and well-equipped laboratories in our universities and technical colleges which might render great service to the industry. To avoid wasteful duplication of work and to co-ordinate the results, it is essential that some organised scheme and allotment of work should be arranged, and it is suggested that a conference of those concerned

should be held at an early date to formulate such a scheme. Even if to-morrow the whole of the available chemical force set to work on some organised plan, it would not be any too soon to get the necessary information together for the use of the existing works and the new works when they are started.

The urgency of this action is further shown by a resolution passed by an important meeting held in Manchester on February 16, which was presided over by Sir Chas. Macara. The resolution, which was carried unanimously, stated: "That in the opinion of this meeting the Government would do well to organise immediately the present chemical talent in the country with a view to chemical research being undertaken for, and on behalf of, all manufacturers interested, and that the services of these experts should be available for all desirous of availing themselves thereof."

The adoption of such a plan for bringing the educational institutions more closely into touch with the industries would in all probability mark the beginning of a new era in which both would benefit. The more intimate association of professors of chemistry with chemical industry would introduce into the works that higher ideal and broader scientific spirit upon which successful research and development depend, whilst the schools would benefit by the great incentive of practical reality.

The Parliamentary Debate.

Since the above was written, the important debate in the House of Commons on Monday, February 22, has advanced the matter another stage. The criticisms offered by various speakers raised few novel points, and the general tone of the debate was, on the whole, favourable to the Government scheme. Several speakers, including Sir Philip Magnus, expressed the opinion that the grant of 100,000*l.* for research work was totally inadequate. Mr. A. Chamberlain and others emphasised the great difficulties the undertaking would have to face on the conclusion of the war, and many speakers acknowledged that the question of the manufacture of dyes was of such a special character as to warrant quite exceptional treatment.

Mr. Runciman, speaking on behalf of the Government, made the interesting announcement that upwards of 400,000*l.* has already been subscribed towards the capital of the new company, and further stated that the signing of the five years' agreement was not an essential condition of subscribing capital, but that priority of supply would be given to those who had given the undertaking. His concluding remarks may be quoted: "I am surprised that anyone should suggest that we have not adequate chemical knowledge in this country. We have sufficient first-class men, but we lack an adequate number of second-class chemists, which we shall not produce if they are only paid 3*l.* a week.

"Even if this were only an emergency scheme the million pounds promised by the Government would be well spent. A single month of unemployment in the textile trade would mop up more than that of our national money. It is the disadvantage of all practical schemes that they are full of compromises, but no step has been taken without a practical reason."

WALTER M. GARDNER.

ON COLOUR SENSITISED PLATES.[1]

II.—THEIR APPLICATIONS. PANCHROMATIC PLATES. TESTING DYES, ETC.

The commercial "ortho-" or "iso-chromatic" plates, which are specially sensitised for green, besides their obvious uses for scientific purposes in which red sensitiveness is not necessary, are of especial use in the photography of coloured objects where an improved result, as compared with an ordinary plate, is desired, rather than a full correction. As the unassisted eye is not a very keen critic of the relative brightnesses of different colours, especially when they are not in juxtaposition, such an improvement is often all that is necessary. The deficient sensitiveness to red causes a pure red to be represented as if it were black. But almost all colours in nature and most artificial colours are not pure, and so far as a red contained any green or white, that is so far as it reflected any other light whatever in addition to the pure red, except pure blue, then the rendering of the red would be improved. But this fact as to most natural colours being mixed is also a disadvantage, for all coloured objects, so far as they reflect any red, will suffer because of the want of red sensitiveness of these plates.

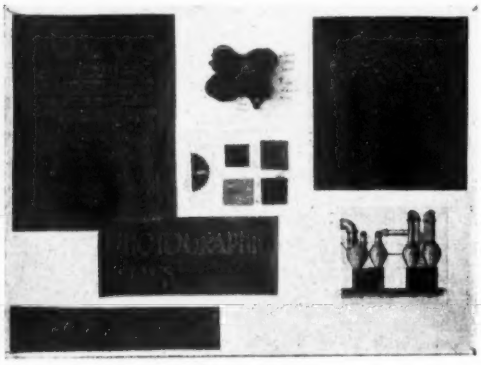
Plates are made specially sensitised to red and called red and yellow sensitive, and practically all that has been said with regard to green sensitised plates, both now and in the previous article, applies to these, only that the deficiency here is green instead of red.

By the use of more than one sensitiser, plates may be sensitised to both green and red, and the early panchromatic plates were of this type. They had three maxima of sensitiveness, one in the blue due to the plate (that is, the silver bromide) not specially sensitised, and one in the green and one in the red due to the two sensitisers. Such plates may be regarded as being as much of an improvement on "orthochromatic" plates as these are on ordinary plates, but the sensitiveness is uneven, and they consequently suffer as already described. By the careful selection and combination of sensitisers this unevenness has been very largely overcome in the panchromatic plates of the present day. Excessive blue sensitiveness of course remains, but this is easily obviated by a pure yellow filter.

The three illustrations (Fig. 2, *a*, *b*, *c*) show the effects of various colours by the use of ordinary, orthochromatic, and panchromatic plates, respectively. The colour filter used with the orthochromatic plate might with advantage have been

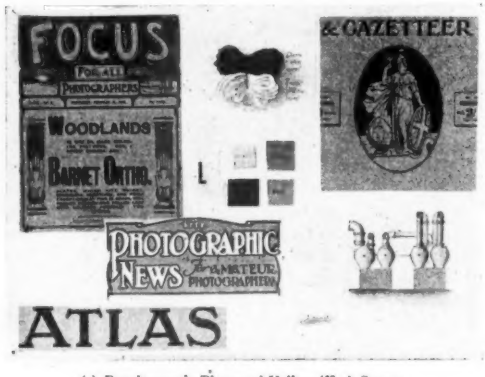
[1] Continued from p. 677.

rather darker. The "L" near the middle is deep blue, the word "mark" is white, and the ground they are on is yellow. The book covers are red. It will be noticed how the panchromatic plate gives the yellows better than the orthochromatic plate,



(*a*) Ordinary Plate.

(*b*) Isochromatic Plate and Yellow (×4) screen.



(*c*) Panchromatic Plate and Yellow (K 3) Screen.

FIG. 2.

and gives the reds, which the orthochromatic plate renders in the "Gazetteer" and "Atlas" as if the red paper was of the same colour as the black printing ink. Other effects will be clear without further description.

Panchromatic plates have been made commercially for fifteen years or more, but the plates of the last few years are very superior to their predecessors. Some makers issue more than one kind, the variation so far as colour sensitiveness is concerned being chiefly as to the extent of the red sensitiveness. Some are sensitive only to about the red lithium line or the C line in the solar spectrum. Others are sensitive to beyond the A line or the red potassium lines, and plates can be supplied that are sensitive considerably further into the infra-red. For the correct representation of coloured objects infra-red, and even the extreme red, sensitiveness is only harmful, just as ultra-violet sensitiveness is, because these radiations are dark to the eye. It is well to choose a plate for this purpose that is not sensitised to the extreme red, and it is necessary to use a colour filter that cuts off the ultra-violet (some of the older yellow filters did not do this) and reduces the intensity of the blue so that it does not produce an undue effect. With a modern panchromatic plate a suitable filter will require the exposure to be increased perhaps only five times, as compared with the exposure necessary for a white object without the filter. This does not mean that such a plate and filter will give a sensitiveness curve that will exactly coincide with the luminosity curve of the solar spectrum, but it is a very near approach to it, so near that for general purposes it is more important to see that the present degree of perfection is maintained, rather than that it is increased, though of course we hope for still better results in due time.

There are many uses to which colour sensitised plates and colour filters may be put besides the correct representation of colour luminosities in the photography of objects, spectrum photography, and in connection with three-colour reproduction processes. Given black and white and any single colour, it is possible to photograph the three so that the colour is represented as if it were *either* black or white. Take the simple case of a drawing or manuscript in black ink on white paper with alterations in red ink. The red alterations can be made to appear as black as the black ink by using blue (or blue and green) light only, that is, a light which has no red in it. An ordinary plate, which is sensitive only to blue, will give this result. But the red alterations can be made to appear as white, and therefore to disappear, by using red light only, that is, a plate sensitised to red in conjunction with a red colour filter. Engineers' drawings in blue, as when copied by the ferroprussiate process, give poor contrast on ordinary plates because the active light is chiefly blue, but with a red sensitised plate and red (or yellow) filter the blue becomes practically black. Similarly it is often possible in photography to eliminate stains on documents, or to find an inscription that has faded into invisibility. In this latter case it may be well to use extreme measures, as including as much ultra-violet as possible in one experiment, and the

extreme red in another, if the colour character of the detail being searched for is unknown.

By modifying such extreme measures as just described, it is obviously possible by photography to intensify or diminish the apparent effect of any colour, and so, as for example in stained physiological sections, to improve on the original, or from one original to get two (or more) photographs that represent the section in, as it were, two (or more) different conditions as to staining.

The photographer has also by such means a very large measure of control over the effect of mist. The writer has shown that light is scattered by particles of a diameter equal to half a wave-length of the scattered light. By passing a brilliant pencil of light through a flask of filtered distilled water the path of the pencil may be scarcely visible (the "Tyndall effect"). But by photographing the arrangement on an ordinary plate, that is, using blue and ultra-violet light, the path of the light will probably be shown very conspicuously indeed, the particles that escaped removal by filtration being not large enough to scatter light of greater wave-length than the ultra-violet and the extreme blue. When the particles of the mist or turbidity are graduated in size, as they generally are, and are not coarse like the dust that may be stirred up from a dry road, then the longer the wave-length of the light used the less does the mistiness show in the photograph. When the air is misty, by the use of a yellow filter distant objects may be photographed more clearly than they can be seen, and by using only infra-red light Prof. Wood has obtained photographs in which the sun shines, though there was only a grey cloudiness visible.

Though the colour sensitising of plates is now as much the manufacturer's business as the preparation of emulsions and the coating of the plates therewith, the experimentalist may wish to try the effect of a dye for himself. The solution must be very weak indeed, say one of the dye to from 10,000 to 50,000 times its weight of water. Ammonia is often advantageous to the extent of one per cent. of the whole. The best formula is simply a matter of experiment. The following, for example, is a varation recently published by Messrs. Michaud and Tristan (*Brit. Jnl. of Phot.*, lxii., 56) for sensitising for the red and infra-red:—

Alcohol 50 per cent., 200 c.c.
Ammonia, 4 c.c.
Alizarin blue S, 0·04 gram.
Silver nitrate 10 per cent. solution, 5 drops.

The same dye is efficient without the silver salt and the alcohol, but presumably these are advantageous. In general, after the plate has been in the dye solution for two or three minutes, it is washed for a few minutes and then dried. Plates so treated vary very much as to the time that they will remain in good condition. For example, plates bathed in the solution quoted above must be used within a few hours, but in other cases they may last for months.

It is much less risky to make colour filters than to bathe plates, as most dye solutions will be absorbed by a clean gelatine film. But colour filters are now made by several firms, and the Wratten department of Kodak catalogues standardised colour filters of nearly a hundred different transmissions. CHAPMAN JONES.

PROF. G. F. J. ARTHUR AUWERS.

THE brief paragraph in our issue of last week, announcing the death of Prof. Auwers, must have been read with the deep regret that follows the loss of one who long occupied a commanding position in the world of science, and whose place it will be difficult to fill. For more than fifty years he had illuminated the science of astronomy, and by providing much of the material by which it is hoped to attack successfully the problem of the structure of the sidereal universe, he linked together the astronomical thoughts and methods of the past with the philosophical problems that engross and captivate the attention of astronomers of to-day.

In the history of astronomy of position, by which is understood the accumulation and arrangement of facts depending on a star's place in the sky, three names stand out prominently. Bradley, in whose valuable series of observations, long waiting for an interpreter, lay hidden the secret of stellar proper motion; Bessel, who made these measures available to the astronomers of his day; and Auwers, whose early appreciation of the necessity of the highest accuracy gave to these observations an increased value by his long and patient examination, laying the foundation of that system of thorough uniformity which has welded meridian observations into a more consistent whole, facilitating the combination of star catalogued places on a common basis, by the removal of systematic errors or discrepancies. Auwers taught the necessity for a higher standard of accuracy, and it is not too much to say that in the department of reduction and discussion of observations he long stood without a rival. His *forte* lay in the control and management of large masses of work, in the unhurried, careful supervision of every stage, bringing an acute and trained judgment to bear equally on all parts of the investigation.

If his reputation rests especially on his re-reduction of Bradley, it must be remembered that he encouraged and assisted other large undertakings. He took a prominent part in the re-observation of the Durchmusterung zones, a work of many years' international co-operation successfully carried out under the auspices of the Astronomische Gesellschaft. He was among the first to investigate the proper motion of faint stars, and he foreshadowed some of the conclusions that have been established by the most modern and thorough of inquiries. The determination of solar parallax by the method of the transit of Venus is a somewhat discredited problem now, but forty

years ago it occupied a very conspicuous position, and Auwers's work on the German share in the complete investigation exhibits at least all that could be derived from the process. Of still earlier date, and of unquestioned excellence and success, were his discussions of the variable proper motion of Sirius and Procyon. How brilliantly his location of the position of the unsuspected satellites was justified, is well known.

It would be impossible to do justice in a short notice to talents so varied and to an industry so active as Auwers exhibited throughout a long career, but it may be permitted to say that, notwithstanding the bitter estrangement that separates us from German thought and German ambitions, every English astronomer would be willing to lay a tribute of respect on the grave of Arthur Auwers. W. E. P.

NOTES.

SIR ANTHONY A. BOWLBY has been chosen Bradshaw lecturer of the Royal College of Surgeons of England for the ensuing year.

IT is announced in *Science* that Prof. R. H. Richards, professor emeritus in the Massachusetts Institute of Technology, has been awarded the gold medal of the Mining and Metallurgical Society of America in recognition of his services in the advancement of the art of ore dressing.

AT the meeting of the Royal Geographical Society on Monday, February 22, Dr. Page, the American Ambassador, presented to Dr. Scott Keltie, secretary of the Royal Geographical Society, the Cullum gold medal for long and eminent service to geography, awarded by the American Geographical Society.

THE gold medal of the Institution of Mining and Metallurgy—the "blue ribbon" of the profession—has been awarded to a distinguished Canadian, Dr. Willet G. Miller, provincial geologist of Ontario, in recognition of the eminent services rendered to mining by his admirable work as an economic geologist.

THE officers of the Royal Astronomical Society elected at the annual meeting on February 12 were as follows:—*President*, Prof. R. A. Sampson; *Vice-Presidents*, Dr. J. W. L. Glaisher, Major E. H. Hills, Dr. W. H. Maw, and Prof. H. H. Turner; *Treasurer*, Mr. E. B. Knobel; *Secretaries*, Prof. A. S. Eddington and Prof. A. Fowler; *Foreign Secretary*, Prof. Arthur Schuster.

PRINCE B. GALITZIN has been elected an honorary fellow of the Physical Society. The following is the list of officers of the society elected for the ensuing year:—*President*, Sir J. J. Thomson. *Secretaries*, Dr. S. W. J. Smith (Royal College of Science, S.W.), and Dr. W. Eccles (University College, Gower Street, W.C.). *Foreign Secretary*, Dr. R. T. Glazebrook. *Treasurer*, W. Duddell. *Librarian*, Dr. S. W. J. Smith.

AT the annual general meeting of the Geological Society, held on February 19, the following officers were elected:—*President*, Dr. A. Smith Woodward; *Vice-Presidents*, Dr. H H. Bemrose, Mr. Clement Reid, Dr. A. Strahan, and the Rev. H. H. Winwood; *Secretaries*, Dr. H. H. Thomas and Dr. H. Lapworth; *Foreign Secretary*, Sir Archibald Geikie, O.M., K.C.B.; *Treasurer*, Mr. B. McNeill. The president's address delivered at the meeting dealt with the evolution of the fishes in geological time.

THE virtual German monopoly in the manufacture of dye-wares is a matter of national concern in other countries as well as in Britain. It is announced that arrangements have been made by the Benzol Products Company of Philadelphia to commence dye manufacturing on a large scale in about six months' time. A new company, styled the "Russian Society of Chemical Industry," has also been formed in Moscow to manufacture dyes for the sixty large consumers in that district.

ON Tuesday next, March 2, Prof. W. J. Pope will begin a course of two lectures at the Royal Institution on colour photography (scientific applications): (1) "Photographic Appreciation of Colour in Monochrome"; (2) "Photography in Natural Colours"; and on Thursday, March 4, Sir Herbert Warren will begin a course of two lectures on poetry and war. The Friday evening discourse on March 5 will be delivered by Prof. E. B. Poulton on mimicry and butterflies, and on March 12 by Sir Rickman J. Godlee on back to Lister.

NEWS has been received of the arrival at Khartum of Dr. C. Christy, who has been engaged during the past three years on a zoological mission in the Belgian Congo undertaken officially on behalf of the museum at Tervueren. We hear that he has made very large collections of the animals of the Ituri forest and other regions of the Congo traversed by him, though it is difficult to say what is to become of the specimens under the conditions existing in Brussels. Dr. Christy was fortunate in shooting two okapi, thus joining the very small band (not more than three or four) of white men who have shot an okapi. Nearly all the specimens now in Europe were killed by natives. Dr. Christy's bag also included several specimens of Meinertzhagen's great black forest pig and many of the dwarf Ituri buffalo.

Science announces the following deaths of men known in the scientific world:—Dr. Anthony Woodward, at one time assistant in the department of geology and for thirty-seven years librarian of the American Museum of Natural History, New York City; M. Alfred Tournier, formerly professor of viticulture at the University of California and later connected with the U.S. Department of Agriculture, who was killed on December 12 in the war; Dr. C. F. Brackett, professor emeritus of physics in Princeton University, in his eighty-second year; Dr. B. Sharp, formerly corresponding secretary of the Philadelphia Academy of Natural Sciences and professor of invertebrate zoology there and in the University of Pennsylvania, aged fifty-six years.

WE regret to announce that among the victims of the war must be numbered M. Joseph Déchelette,

the eminent French archæologist, who was killed in action on the Aisne on October 4 last, at the age of fifty-three. His most important work was the "Manuel d'archéologie préhistorique celtique et gallo-romaine," which, unhappily, after the issue of two volumes, remains unfinished. He also, in collaboration with M. E. Brassart, published "Les peintures murales du Moyen âge et de la Renaissance en Forez." He was also the author of works on "L'oppidum de Bibracte," "Les fouilles du mont Beuvray," and "Vases céramiques ornés de la Gaule Romaine," for which he was awarded the medal of the Académie des Inscriptions et Belles-Lettres, and was appointed Chevalier of the Legion d'honneur. The death of this indefatigable archæologist, who was Conservateur of the Musée de Roanne, is a serious loss to French archæology.

ALTHOUGH much of the activity of research laboratories has been curtailed by the war owing to the patriotic action of the younger workers joining one of the Services, there remain a number of men and women carrying on research. In the subject of chemistry special difficulties have arisen because practically all very pure chemicals have hitherto been made in Germany. No very large stock of chemicals of this description is held by dealers, but researches either completed or abandoned have left a considerable amount in public and private laboratories in this country. In an attempt to render these stocks available to workers, the chemical department of the Imperial College, South Kensington, has started a bureau of exchange. Circulars have been sent to most of the university and college laboratories in the kingdom asking for lists of chemicals which are not in immediate use. Many lists have already been sent, and workers who are in urgent need of fine chemicals have been put into communication with those who have some to dispose of. It is hoped that any chemist who has not received the circular will communicate with the bureau giving a list of the materials he has available and also his requirements. As a rule, chemicals have been sold at cost price, but the financial arrangements are left entirely to the buyer and seller.

THE Medical Committee of the British Science Guild has done a good work by its resolution condemning a notorious anti-vivisection advertisement. The object of the advertisement was to prevent our soldiers from being protected against typhoid fever. If it be asked why any one of the many anti-vivisection societies should behave in this way, we can only say with Dr. Watts that "Satan finds some mischief still for idle hands to do." Anti-vivisection since August has been more or less short of work. Few of us are wanting to hear Pasteur called a charlatan; few of us are wanting anti-vivisection lectures and shops. Everybody is sure, who is capable of clear thinking, that our men of science are neither cruel nor stupid. But anti-vivisection cannot rest. It must find something to attack, something to abuse. Happily, by mere vulgar abuse, it does itself more harm than good; and we may well believe that quiet, level-headed, charitable folk are mostly by this time sick of the very name of anti-vivisection. We hope that it will be many years before anti-vivisection emerges out of the public disgrace which it has brought upon itself. The resolution of the British Science Guild is fairly outspoken, though it might justly have used stronger language. We hope that it will be very widely circulated; half a million copies, distributed through the country, would be none too many

THE second Indian Science Congress was held, under the auspices of the Asiatic Society of Bengal, in Madras, from January 14 to 18 last. There was a large and representative attendance of delegates from all parts of India, and the Hon. Surg.-Gen. Bannerman, I.M.S., who is president, delivered an address. According to the *Pioneer Mail*, the president insisted on the importance of a knowledge of biology to medical, sanitary, and scientific men working in the tropics. In the course of an appeal to wealthy Indians to endow medical research so that their poor but capable fellow-countrymen might have something to look forward to as a reward for scientific toil, Surgeon-General Bannerman said:—"There are plenty of subjects for research which ought to be endowed, chairs in our medical schools and universities that ought to be established all over India. Indian universities are at present mere skeletons. Will no one here take up the rôle of beggar and try to extract a few lakhs of rupees from the hoards of his wealthy and aristocratic friends?" Continuing, he said India wants to have, not only more chairs and lectureships, but also research scholarships or fellowships, established fellowships, available for a student and research worker, so that he may live in reasonable comfort and be able to devote his whole energy to work, without anxiety for those depending on him. In Madras a beginning has been made in this direction, owing to the enlightened liberality of the Raja of Pithapuram, who has presented 50,000 rupees for the expenses of an inquiry into diabetes, the fell disease which has carried off so many of the best brain workers in this part of India.

THE authorities of the Sheffield Public Museums are to be congratulated on the attention they are devoting to the collection and classification of documents and other records relating to local history. The systematic collecting of such records, as we learn from the report for the period from March, 1912, to March, 1914, was commenced at the High Hazels Museum in 1901, and afterwards extended to the establishment in Weston Park. The gift to the Public Library of the "Jackson Collection," rich in documents relating to Sheffield, has largely added to the value and interest of the series, which is now very extensive.

"PIGMY" stone implements form the subject of an article, with two plates, by Mr. C. Hartley in *Spolia Zeylanica* for December last (vol. x., pt. 36). Such implements occur locally in many parts of the world, including the British Islands, but they are nowhere more common than in Ceylon, where they occur in great profusion at Bandarawela. At least ten distinct types of these implements are recognised by the author, but axe-heads, together with saws, spear-

heads, and punches, are totally wanting. The question whether the pigmy and the ordinary Neolithic types of implements were manufactured and used simultaneously by a single race is, for the present, left without a definite answer.

IN *Man* for January Mr. Edge Partington supplies a graceful obituary notice of Mr. Norman Hardy, one of the best of our anthropological artists, who died about a year ago. His work began with illustrations for Dr. Beddoes's "Races of Mankind." He travelled widely in Australia and the Pacific, and some of his best drawings appeared in "The Savage South Seas" and "Women of all Nations." In 1907 he went to the Kasai with the expedition led by Mr. E. Torday, and his last work was the tracing of the wall paintings in the tombs of the Kings at Thebes. He was for many years an active member of the Royal Anthropological Institute, where the simplicity and kindliness of his nature, as well as his skill as an artist, won him the regard of many friends.

IN the proventriculus of the flea there is a valvular arrangement of chitinised spine-like epithelial cells which normally prevents the regurgitation of blood from the stomach during the act of sucking. A. W. Bacot and C. J. Martin have shown that in the plague-infected flea this mechanism is upset by a copious growth of plague bacilli which gets entangled among the spines, thus allowing the regurgitation of infected blood and the infection of a new host. In the fourth Plague Supplement of the *Journal of Hygiene* (January), this mode of transmission of plague by the flea is further elucidated by Bacot as the result of a study of serial longitudinal sections of infected fleas. Bacot also shows that in cool weather fleas are able to survive and to carry *B. pestis* for periods up to forty-seven days in the absence of any host, and afterwards to infect mice. He also shows that under experimental conditions bugs can transmit plague from mouse to mouse. Active healthy mice, however, eat the bugs, and an ingenious arrangement is described whereby the bugs are given shelter in saw cuts in the walls of wooden tubes in which the mice reside. Blood in the bug's stomach does not form so favourable a medium for the growth of the plague bacillus as in that of the flea, and it would therefore appear that the bug is not likely to be an active carrier of the infection under natural conditions.

THE June number of *Peru To-day* contains an article entitled "The Conquest of Verruga," by Mr. C. H. T. Townsend, entomologist to the Peruvian Government. The author gives a brief summary of the results of his investigations upon Verruga Peruana, a disease which causes great ravages and much mortality in the Andes, and he claims to have solved the problem of the etiology of the disease and to have proved conclusively that it is transmitted by a tiny fly, a species of Phlebotomus, to which he has given the name *P. verrucarum*. The fly is crepuscular and nocturnal in its habits, remaining hidden by day in caves or in crevices in rocks and in the walls of human habitations. Protection against the fly, and consequently against the disease, can be obtained by sleeping under muslin-nets, by applying ointments to the exposed parts of the body just before dark, and by the use in bedrooms of electric fans arranged in such a way as to direct strong currents of air towards the open windows through which the flies come in. The flies appear to breed in the canyons in which there is sufficient moisture to support a luxurious vegetation, but not in the dry canyons without vegetation; the life-history of the fly has not yet, however, been observed. The author believes that small rock-lizards constitute a reservoir for the disease, and that the flies, which feed naturally on the blood of these reptiles, transmit the virus from them to human beings.

ONE of the most difficult problems with which the museum curator has to deal is to find a satisfactory method of presenting fishes for public exhibition. Stuffed specimens are an abomination; spirit specimens, however cunningly painted, are worse; and the ordinary type of cast is altogether wanting in sharpness and definition, owing to the external layer of plaster being disintegrated by the mucus from the skin during the process of setting. For the latter defect Messrs. Gill and Fletcher, of the Hancock Museum, Newcastle-on-Tyne, claim, in the February number of the *Museums Journal*, to have found an effectual remedy, and, judging from the figure of one ready for painting, their casts certainly seem to be a great improvement on the old-fashioned type. A continuation of the article is to follow.

"AN Appreciation of Theodore Nicholas Gill," illustrated by a portrait in academical robes, is the title of an article communicated by Prof. A. Lucas to the January number of the *American Museum Journal*. Dr. Gill, who died in September last, is regarded by the author as having possessed an extraordinary grasp of various branches of zoology, and this despite a natural indolence, which led him to forgo personal investigation, and to rely largely on the work of others as a basis for his own generalisations. Among the latter "were the recognition of the claim of the elasmobranchs to a position of the 'highest' rank, and of the purely artificial nature of the groups Carinatæ and Ratitæ among birds." As regards the latter item, his views, which are undoubtedly correct, were diametrically opposite to those of the late Prof. Alfred Newton.

MR. S. TABER discusses the earthquakes of the Charleston district in the Bulletin of the American Seismological Society of America (vol. iv., 1914, pp. 108-60). The earthquake-series of 1886 was preceded by a prolonged interval of repose, only eight shocks being recorded during the previous two centuries. Since August, 1886, the decline of the after-shocks in frequency has been gradual though fluctuating, 318 being reported from 1886 to 1897, and 77 from 1898 to 1913. The shocks are most frequent in September and rarest in April. Mr. Taber considers the relations between earthquake-frequency and various meteorological and astronomical factors. He finds that shocks are most frequent after long-continued periods of local rainfall, when the pressure of the underground water is relatively greatest on the north-

west side of the originating fault, and when the barometric gradient is directed to the south-east. On the other hand, he can discern no relations between earthquake-frequency and changes in barometric pressure or the tides of the neighbouring coast or sun-spot maxima or lunar periodicities.

DR. E. WARREN gives, in the Annals of the Natal Museum for September, 1914 (vol. iii., pt. 1), a full and well-illustrated description of a remarkable plumularian hydroid zoophyte discovered on living oysters in 1911 on the coast of Pondoland, of which a preliminary notice has already appeared. Although nearly allied to those species of Plumularia with hydrothecæ arising from the main stem, it differs by the presence of pinnules on some of the pinnæ, thereby approaching Schizotricha, in which nearly all the pinnæ are thus furnished. It is therefore provisionally included in that genus, as *S. simplex*. Its main claim to interest is, however, connected with its reproduction, which is of a unique type. Instead of the egg being furnished with a yolk-supply sufficient to maintain the young until capable of foraging for itself, as in the great majority of invertebrates, "the egg remains quite small and is never provided with a perceptible quantity of yolk, but segments, and development takes place, in a kind of maternal placental tissue which supplies the embryo with food during the whole development." In another article in the same issue Mr. H. C. Burnup reviews the minute pyramidal striated S. African land-snails of the genus Ennea, with descriptions of new species and races.

THE recently received number of the *Philippine Journal of Science* (vol. ix., sec. c., No. 4, August, 1914) contains two papers by Mr. E. D. Merrill, in which no fewer than ninety-three new species of Philippine plants are described. Forty-three were collected by Wenzel in the island of Leyte, whose collections have already added very largely to a more complete knowledge of the rich flora of the archipelago. The other new species come from various islands, and are included in Mr. Merrill's tenth and concluding instalment of new or noteworthy Philippine plants.

STEPS are being taken to secure the trade in senna in British hands. The plant from which the finest quality of senna is obtained grows in the Sudan, where the leaves and pods are collected and dried by natives, and sold to collecting agents for export. At one time this trade was entirely British, and the produce was sold through London, but afterwards it passed into German hands. The Imperial Institute has been in communication with the chief British importers and with the Egyptian Government, and the export of senna from Egypt has now been prohibited except to the United Kingdom and France. British firms are making arrangements direct with the native growers, which should not only restore the trade to this country, but lower the price and secure the purity of the supply.

MR. W. G. REED, of the Department of Geography of the University of California, presented a paper, "Climatic Provinces of the Western United States," to the Cordilleran Section of the Geological Society of America, and this paper has been printed in the Bulletin of the American Geographical Society (vol. xlvii., No. 1). After discussing various classifications, such as those of Supan and Herbertson, Mr. Reed advances a new classification based upon considerations of rainfall, temperature, and relief. The area from the coast to the Rockies is divided into four main regions, a northern and southern coast strip divided at 40° N., and a northern and southern "rain-shadow" strip divided about 43° N. The coast strips are subdivided mainly for topographical reasons into smaller divisions. The main divisions are, on the whole, just, since the whole rain-shadow area is characterised by a relative raininess in the month of May, which is lacking along the coast strip, but it seems probable that Mr. Reed has not made sufficient allowance for two facts regarding the coast strip. In Washington the month of maximum raininess is November, and the further south one goes the later in the season does this maximum occur, and at the same time the relative raininess shows considerable increase. Probably these facts would have commanded attention had Mr. Reed made rainfall graphs in a generalised form for his subdivisions instead of taking single places as types.

IN the *Philosophical Magazine* for January Mr. A. E. Young obtains formulæ for the effect of stiffness and stretching on the form of a suspended wire or tape. The importance of these investigations largely depends on their application to the steel tapes and other substitutes for the old chain in modern surveying.

IN a paper communicated to the Proceedings of the Cambridge Philosophical Society (xviii., 2), Dr. Norbert Wiener proves in a short note that the shortest curve dividing a given area in a given ratio consists of a circular arc or a number of such arcs, each terminated on the boundary of the area. The paper was originally intended to be a joint article by the author and Dr. Szász, and to contain a proof that the shortest curve dividing any scalene triangle in a given ratio is a circular arc with the most acute apex as centre. Owing to the war this has not been possible, but the results are so self-evident to an average English mathematician that no advantage would have been gained by a further discussion in print. The simplest plan is to replace the author's words, "dividing an area in a given ratio" by "cutting off a segment of given area from a given closed figure." The proof that the portion of the curve joining any two points on it is an arc of a circle is found in most text-books, and the reader should have no difficulty now in seeing, further, that the arc in question must meet the boundary at right angles (unless it passes through a re-entrant angle), whence the property which Dr. Szász intended to prove follows immediately.

THE December number of *Terrestrial Magnetism and Atmospheric Electricity* contains the results of the determinations of the deviation of the compass made on the magnetic survey ship *Carnegie* during her voyages from Brazil to St. Helena in 1913, and from

Norway to Iceland and thence to New York in 1914. The published charts of the South Atlantic all show the westerly deviation too small by a degree, or in one or two cases nearly two degrees, in the region 30° S., 24° W. Between Norway and Iceland the charts show deviations to the west 2° or 3° too small, between Greenland and Labrador they are 1·5° to 2° too high, and the British chart is nearly 3° too low at 55° N., 52° W. Along the east coast of America there are no serious errors in the charts as at present issued, although the U.S. chart is the least accurate of the three available.

SCIENTIFIC PAPER No. 231, issued by the Bureau of Standards, is devoted to a determination of the specific heat of copper over the temperature range 10° to 50° C., by Mr. D. R. Harper, of the bureau. The specimen of copper consisted of 50 metres of very pure annealed wire of 2·5 millimetres diameter wound into a compact coil 10 cm. diameter and 10 cm. long, with thin sheets of mica to maintain the insulation. The coil was suspended by silk threads in a vacuum vessel, and heated by an electric current sent through it. The current and potential difference at two points near the ends of the wire were determined by a potentiometer method. The standardisation of the wire as a resistance thermometer was carried out by the bridge method with the help of two standard platinum resistance thermometers. During the determination of specific heat the copper wire served as test specimen, as calorimeter, and as thermometer. The final result for the specific heat is $0{\cdot}0917+0{\cdot}000048(t-25)$ calories per gram degree.

A COPY of a "Biographical Sketch of James Smithson" has been received from the Smithsonian Institution at Washington. It is an abridgment of a chapter on James Smithson by the late Dr. S. P. Langley in "The Smithsonian Institution, 1846–1896: the History of its first Half Century." The founder of the institution was born in 1765. He graduated at Pembroke College, Oxford, in 1786. At a time when the study of physical science was almost unknown in the University, he appears to have conceived already that devotion to scientific research which characterised all his future life. He was admitted as a fellow of the Royal Society in 1787, his recommendation being signed, among other men of science, by Cavendish, who became an intimate friend. Arago, too, was added to his friends later, and he was a correspondent of Black, Banks, and Thomson. Smithson died at Genoa in 1829. His will provided that in the event of the death of his beneficiaries, his property should pass to the United States of America "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." Thus his dearest wish that "my name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten" seems likely to be accomplished.

AN electric tramway—described in *Engineering* for February 19—has been constructed recently to connect Osaka, which is the foremost industrial and commercial centre of Japan, with the town of Nara. The line is 19 miles long, and the steepest gradient is 1 in 30. The cars, which accommodate 100 passengers, and weigh 32 tons when fully loaded, are mounted on two trucks equipped with 160 horse-power motors. It was desired to keep the line as straight as possible, and the route selected for this reason involved the construction of four tunnels, the most important of which is the Ikoma tunnel. In cross-sectional area, this tunnel is the largest in Japan, and its length, which is 11,088 ft., is only exceeded by that of the Sasago tunnel on the Imperial Japanese Government Railways. The tunnel penetrates the Ikomayama Mountains, which rise to a height of 1500 ft. above sea-level. No shafts were used in the construction; work was commenced from both ends simultaneously in July, 1911, and the tunnel was completely finished in April last.

THE publishers of the *Revue générale des Sciences pures et appliquées* (Librairie Armand Colin, 103 Boulevard Saint-Michel, Paris, 5e), have issued general indexes of the contents of the first twenty-five volumes (1890–1914) of our contemporary. There are two indexes; one is a subject index arranged under twenty headings according to the branch of science with which the articles are concerned, the other is an index arranged under authors' names. These excellent indexes will save readers much time and trouble when anxious to trace an article published several years ago. The price of the publication is 3·50 francs.

MESSRS. G. BELL AND SONS, LTD., announce the publication at monthly intervals of sets of "Test Papers in Mathematics" for use in secondary schools. The series will be begun in May, and the first three sets to be issued will be compiled respectively by Mr. G. W. Palmer, Prof. T. P. Nunn, and Mr. H. C. Beaven.

OUR ASTRONOMICAL COLUMN.

COMET NEWS.—A telegram from Prof. Strömgren, dated February 19, announces the discovery of an object by Miss Leavitt as Metcalf's periodical comet (1906 VI.). The discovery was made on February 9 at 12h. 33·7m. Harvard mean time, the position of the object being given as R.A. 8h. 30m. 37s., declination $-1°\ 38'\ 42''$. No idea of the brightness of the comet is given, but as perihelion was passed last June the object may be considered very faint.

With regard to Mellish's comet, a further telegram gives details of an observation made at the Tashkent Observatory, Russia. On February 15, at 17h. 31·0m. Tashkent mean time, the comet's position was R.A. 17h. 9m. 11s., declination $+2°\ 47'\ 43''$.

A numerous and interesting series of observations of Delavan's comet (1913*f*) is contained in the latest issue (November) of *L'Astronomie*. M. Quénisset contributes several photographs taken in August and September last illustrating the development of the tail. Of special interest perhaps are the observations of M. H. Law, of Hörsholm, Denmark. This observer made a number of estimations of the brightness of the comet, and found a distinct fluctuation in magnitude in a period of about three weeks. The magnitude of this change is illustrated in a table and

diagram which he publishes in his communication. He shows further that this fluctuation in brightness was closely associated with the direction of the comet's tail in relation to the sun.

MAGNITUDE ERROR IN PARALLAX DETERMINATIONS.—In the January number of the *Astrophysical Journal* Prof. Kapteyn describes a very ingenious device for avoiding systematic error depending on magnitude in the measurement of stellar photographs. If this error could be removed, Prof. Kapteyn does not see why it should not be possible—in the average of a sufficient number of observations or of a sufficient number of stars—to be able to reach almost any desired accuracy. The method of removing the error looks surprisingly simple, and seems to contain a complete solution of the problem. The idea is to obtain stellar photographs on which the stars of all different degrees of brightness are represented by perfectly equal images. To secure this two photographs of the same star region are required. The first photograph is taken when the plate is placed slightly within the principal focal plane of the telescope. On this plate it will be found that after development all the stars will be represented by circles of the same diameter but of different densities depending on the brightness of the stars. This negative is now replaced in the telescope exactly in its former position, the cones of light of the several stars falling on it as before. A second photograph—the main plate—is now taken *in focus*. It will be seen that the light of a bright or faint star before it can reach the main plate will have to pass through a dense or faint film screen respectively. In this way the images are brought nearer to equality. At present only one test has been made, and that not under the best conditions, but the results are certainly very promising.

RADIOMETRIC MEASUREMENTS OF 110 STARS.—A comparison of stellar radiometers and radiometric measurements on 110 stars is the title of a paper by Mr. W. W. Coblentz, which appears in the Journal of the Washington Academy of Sciences for January 19 (vol. v., No. 2). This paper, as stated, is only a brief summary of one to appear in the Bulletin of the Bureau of Standards. Reference is first made to experiments which show that there is little difference in the radiation sensitivity of stellar thermo-couples constructed of bismuth-platinum and thermo-couples of bismuth-bismuth plus tin alloy, which have a 50 per cent. higher thermo-electric power. A stellar thermo-couple was found more sensitive than a bolometer, and greater improvements are expected in the former than in the latter. Measurements were made of the bright and dark bands of Jupiter, the rings of Saturn, a planetary nebula, and 105 stars. Quantitative measures were made on stars down to 5·3 magnitude, and high-grade qualitative measures on stars down to 6·7 magnitude. Red stars were found to emit from two to three times as much total radiation as blue stars of the same photometric magnitude. Measurements were also made of the transmission of the radiations from stars and planets through an absorption cell of water. Of the total radiation emitted blue stars had about twice as much radiation as yellow stars, and about three times that of red stars in the visible region of the spectrum. The object of the investigation was primarily to form some estimate of the sensitivity required to be able to observe the spectral energy curves of stars, and the author was led to conclude that by using a 7-ft. mirror and increasing the sensitivity of his present radiometer twenty times the required sensitivity could not only be reached but was possible.

DETERMINATION OF TIME.—Under the title "Determinación de la Hora por Alturas absolutas, correspondientes é iguales de distintas Estrellas," Sr. Carlos Puente, of the Astronomical Observatory of Madrid, has published a very full account of the best-known methods of determining time by means of altitude observations of the sun and stars. The work consists of four chapters, of which the first deals briefly with the general principles of astronomical time, with its continuous record and methods of transmission. The other chapters discuss in detail the theory and practice of time determination, first by the observation of absolute altitudes based largely on a method developed by Prof. Donner, of Helsingfors, next by equal altitudes of the same object on both sides of the meridian, and thirdly by the observation of two stars at the same altitude. Each method is illustrated by practical examples, and the accuracy of the results is estimated. At the end of the work a number of useful numerical tables are given.

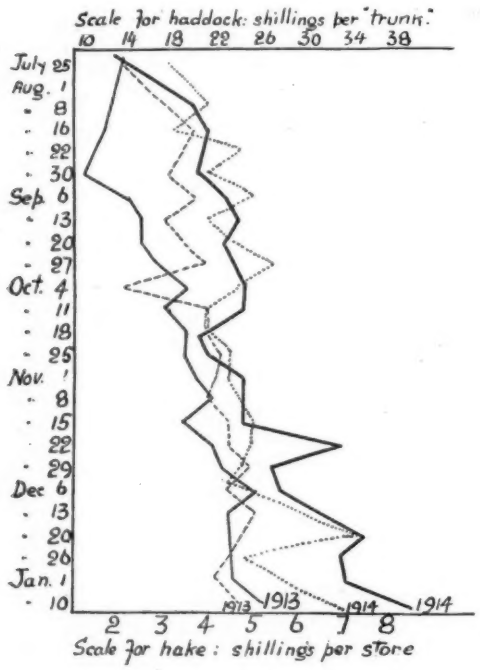
THE SEA FISHERIES AND THE WAR.

AFTER some six months of the war we can attempt to make estimates of its effects upon British industries, and anticipations of the future, with some degree of confidence. This is fairly easy with respect to the fisheries: the industry is being closely studied, and, unlike most, it is the object of both scientific and statistical investigation. The situation at present is one of extraordinary interest, even from a strictly scientific point of view. The enormous restrictions on fishery constitute (unhappily) an experiment on the grand scale, and since the scientific study of the industry has not altogether been allowed to drop interesting results should be forthcoming. The statistics of the next year or two will be of much value, in showing to what extent commercial exploitation of the North Sea depletes the natural resources of that fishing area. Amidst the distractions of the present time this question is not being neglected.

The industry itself has naturally suffered to a great extent. At the beginning of the war it was almost completely disorganised. About the beginning of August practically the entire Grimsby trawling fleet was laid up, and deep-sea fishing had almost been suspended; but at the beginning of October 500 Grimsby vessels had resumed fishing. Exports of both fresh and cured fish fell off to a great extent because of the loss of German trade. That country took more than 90 per cent. of the fresh fish exported from Britain, and about 43 per cent. of the pickled herrings. Russia took about the same proportion of our cured fish. This trade ceased, and at the beginning of August the stock of cured herrings held in Britain was estimated at 300,000 barrels, or about 37,500 tons in weight. How this part of the fishing industry has been affected since then it is still impossible to say. The quantities of fish landed also underwent a great decrease; in September, for instance, this decrease was about 38 per cent. of the quantity landed in the corresponding month of 1913. This falling-off has been due to several causes. A considerable number of trawlers were commissioned as mine-sweepers and patrol vessels—how many it is impossible to say. On August 18 the Navy List contained the names of 107 vessels, and two months later at least 200 of the total Grimsby fleet of 600 ships had been commissioned, or were waiting to be so. In itself this withdrawal of the best vessels, for defence purposes, led to a marked diminution of fishing; and since a large number of the best men were also taken there was a great shortage of officers, so that many

other vessels were laid up. Restrictions, by the Admiralty, on the movements of trawlers, also affected the industry, though as time went on it became evident that some of these restrictions were unnecessary. The positions of the mine fields became known, since it was seen that these had been placed (with characteristic ingenuity) near places from which merchant vessels making for English and Scottish ports took final bearings. The mine danger did not, it appears, frighten the skippers of trawlers very greatly, and the Admiralty even threatened "disciplinary measures" on skippers neglecting their instructions and taking their ships into danger. In fact, the danger of mines was less than had been anticipated. At the end of September eight British steam fishing vessels had been destroyed by mines and twenty-four had been sunk or captured by the Germans. At the end of the year seven mine-sweepers had been lost with fifty-nine casualties, forty men being reported as killed or missing.

Fish became scarcer and dearer, though less so than had been anticipated. The chart below shows the mean wholesale prices[1] of two species of fish (haddock and hake) at Billingsgate Market during each week of the last five months of 1913 and 1914:—



The continuous thin line refers to haddock, and to the year 1913. The continuous thick line refers to the same fish sold in 1914. The broken line refers to hake of 1913; the dotted line to hake of 1914.

Haddocks are essentially North Sea fishes, the percentage taken from that area being about 61 per cent. Hake are southern fishes, and are taken mostly to the south-west of Ireland and towards the Bay of Biscay. There are always violent fluctuations in prices of fish due to the effect of gales on the supply, but apart from these the price rises towards the end of the year. The rise of price over that of 1913 is fairly considerable in the case of the North Sea fish, and much less so in the case of the southern species. But it is far less than anyone might have anticipated at the beginning of August. There was, in fact, a general tendency to keep prices as nearly normal as possible, and it was also seen that the public were certainly not prepared to pay highly exaggerated prices for fish.

The shortage of skippers and mates of fishing vessels is far from creditable to the country. It was pointed out in NATURE some time ago that there was great need for the education and technical training of deep-sea fishermen, and that facilities did not exist. The trawler section of the Royal Naval Reserve was established in 1911, and it was evident two or three years ago that both the Board of Trade and the Board of Education were alive to the necessity for the better technical instruction of deep-sea fishermen. The local machinery was, however, wanting, and the efforts that have been made since 1911 to provide this have been most unsatisfactory. Now the pinch has come. It is no secret that a much larger number of trawlers would be employed in defence operations if officers were obtainable.

The scientific investigation of the sea-fisheries has not been abandoned, but its most important side, the work at sea, has practically been discontinued. This has been unavoidable, and if the organisations in existence before the war can only be kept going a great recrudescence of activity may be expected when peace comes. It must be admitted that the probable defection of Germany from the international investigations will be a great loss. That country has made few original and fertile discoveries in fishery science[2]—it is to Norway that we are principally indebted. But Germany has characteristically carried on routine research in a very thorough manner, and we may miss this in the near future. May we hope that a result of the war will be the determination of Britain to make this research with the honesty and efficiency represented by the German publications. We are only now realising how very painstaking was the German scientific and industrial campaign in the interest of her developing sea fisheries. It was stated a few weeks ago in NATURE that meteorological science had been pressed into the service of warfare by Germany. That has, probably, also been the case with some of the purely scientific results obtained during the investigation of the deep-sea fisheries; and it is a manifestation of *kultur* that we might very well imitate in the future, in peaceful interests. J. J.

[1] The figures are summarised from the weekly lists published by the *Fish Trades Gazette*.

METEOROLOGICAL CHARTS FOR THE MEDITERRANEAN.

PROF. L. MARINI has contributed to the *Annali Idrografici* of the Hydrographic Institute at Genoa a brief descriptive account of the distribution of pressure and wind in the Mediterranean region, together with tables of averages and charts based upon them. The publication is intended primarily for the use of the seafaring man.

The tables of pressure contain normal values for the four seasons and the year for 174 places. The values are given in millimetres, but it is not stated in the tables or on the charts if the gravity correction has been applied nor to what period the values refer. The values are given to two places of decimals which implies a far greater degree of accuracy than would be possible with the instruments used at most of the places; to say nothing of the differences arising from the exposure of the instruments, the reduction to sea-

[2] Perhaps Hensen's quantitative Plankton methods are the exception to this statement.

level, and the hours of observation. The hours are not given, nor the heights of the places above sea-level, nor the months included in the seasonal periods. All these things may be of no interest to the sailor who will be expected to test the charts by his experience, but they are vital to the utilisation of the author's work by other meteorologists either for research or for incorporation in charts for wider areas.

The tables of wind give (1) for sixty-six places the "mean direction" of the wind for each season and the year, computed probably from Lambert's or some similar formula; (2) for seventeen regions of the Mediterranean the frequency of light, moderate, and strong winds for sixteen points of the compass, and the number of calms, also for each season and the year. The regions are roughly about 200 miles square.

The charts have been drawn with a great deal of care and the delineation is clear and attractive. They are on a relatively large scale, and consequently are folded into the book, which makes it troublesome to consult them, but the reader will feel that his trouble is compensated by the ease of seeing rapidly the general features and the details of the meteorological distribution. It may be remarked, however, that charts of normal distribution intended for the seafaring man ought to be printed on good linen-backed paper if they are to be used and not folded and put away in a drawer until a new set is received. Indeed, it is doubtful if the ordinary navigating officer will consult meteorological charts regularly until they are made part and parcel of his everyday equipment by being printed on his navigating charts.

Prof. Marini's charts showing the wind roses for the seventeen regions referred to, are very interesting, bringing out most clearly the relatively stormy winter conditions of the western Mediterranean and the great preponderance of winds from nearly due east or due west between Sardinia and Gibraltar. No wind rose is given for any part of the Adriatic. E. G.

LORD KELVIN'S WORK ON GYROSTATICS.[1]

I.—*Gyrostatic Experiments in the Glasgow Classroom.*

WHEN I was a student, and afterwards when I was an assistant at Glasgow, Lord Kelvin lectured to his ordinary class twice a week, when he was not called away, and his subject was dynamics. About the middle of the session gyrostats made their appearance on the lecture-table, and we had wonderful gyrostatic experiments which filled us with delight, and gyrostatic questions in the weekly class-examinations which were equally productive of dismay. These gyrostatic questions, like many of our exercises in natural philosophy, were often of a numerical character. It is always a good thing to get down to numbers, and it is a most healthful mental discipline to be forced to "get the units right." Our equipment for the solution of these problems was of the slightest, for Lord Kelvin was himself so keenly absorbed in observing the behaviour of the apparatus, that he rather frequently forgot to give us the full dynamical explanation of the curious evolutions which we beheld. I could follow the process of composition of angular momenta, and could see that the axis of resultant angular momentum turned at that rate; but why should that also be the rate of turning of the axis of figure? That was my special difficulty, and it was only afterwards, when I got the idea of steady motion, and saw how the general equation is obtained and how it breaks down into the conditions for steady motion, that the matter became clear. Then I found, moreover, that in the general case there are two possible rates of turning. It is a good thing to stimulate the curiosity of a student to make him find out things for himself: it is also an excellent thing to anticipate his difficulties to some extent, lest he grow weary and faint by the toilsome dynamical way.

The lectures that we had were undoubtedly most interesting and suggestive, though they were not perhaps always directed to the more prosaic topics which formed the staple matter of the degree examination questions for ordinary students. The first experiment made was always that of the equilibrium of this nearly egg-shaped piece of wood, which, scientifically described, is a homogeneous prolate ellipsoid of revolution. Its surface may be imagined to be generated by the revolution of an ellipse about its longer axis. (The diagram, Fig. 1, shows a really egg-shaped solid.) I lay it on its side, and we see that in that position it is stable for fore and aft inclinations, "pitching" I may call the motion, and in indifferent equilibrium for port or starboard displacement, or rolling. This is, of course, all without spin.

If, however, I apply to the solid, as it lies on the tray before me, an impulsive couple with my fingers, so as to make it rotate about one of the minimum diameters (that is, of course, a diameter about which the moment of inertia is a maximum), the solid shows that when spin is applied the equilibrium is unstable.

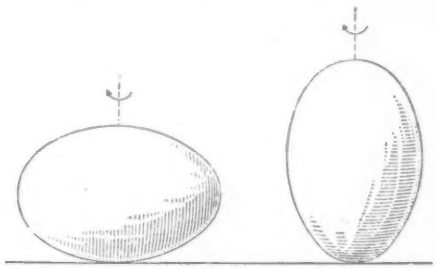


FIG. 1.

The ellipsoid at once sets itself on one end, and then rotates in stable equilibrium with the long axis nearly vertical. This is a very remarkable result. The centre of gravity has been raised, and the equilibrium is now stable. The spin has altered the conditions of equilibrium completely.

Of course, it was pointed out to us that all these phenomena are well shown by the ordinary spinning-top, spun by the unwinding from it of a string when the top has been skilfully thrown from the hand. Schoolboys are not encouraged now (indeed they are *dis*couraged by prefects and other important personages) to play with tops and marbles, and thus many phenomena of spin and collision which some of us used to observe are missed. The swaying round of the axis of a top when rising just after spin to the "sleeping" position, and the similar conical motion of the axis when the top is about to fall, give examples of precessional motion, of, in fact, the astronomical phenomenon called precession of the equinoxes.

Precession was illustrated by the interesting old model of a terrestrial globe which I have here (Fig. 2). You see that the globe is weighted so that a pin projecting from the north pole rolls round a ring, that is, a narrow cone fixed in the earth rolls in the inside of a cone fixed in space. These cones have their vertices at the earth's centre, the axis of the fixed cone is perpendicular to the ecliptic and its semi-angle is $23^\circ\ 27'$, that is, an angle equal to the obliquity of the

[1] Abridged from the Sixth Kelvin Lecture, delivered at the Institution of Electrical Engineers, on January 28, by Prof. A. Gray, F.R.S.

ecliptic. On this ring, which represents the ecliptic, you have the intersections with it of the earth's equator—that is, the equinoxes—and so, as the earth turns, the two intersections move along the ecliptic, the equinoxes precess. The earth, in fact, is a top on which we happen to live, the spin is one turn in 24 sidereal hours, and the conical motion is completed in a period of 26,000 years (Fig. 3). One of our problems was to calculate the diameter of this pin for the earth, or, as it was sometimes put, to find the diameter of the north or south pole! If I remember aright the diameter is about 21 inches.

These were our first gyrostatic experiments and illustrations. I must not omit to mention that the spinning of the ellipsoid was attempted also with each of two eggs, and that with one the experiment always succeeded, and with the other always failed. The reason of this failure and success was interesting; and although some students laughed at the experiment, it nevertheless arrested the attention of all. The contents of one egg were a viscid liquid, the contents of the other had been subjected to a process of coagulation by prolonged exposure to an elevated temperature. In other words, one egg, the one that would not spin on end, was raw, the other had been boiled hard. I now repeat this experiment, which is the scientific solution

FIG. 2.

of the famous problem of Christopher Columbus, to make an egg stand on end.

It is very easy to show, on principles which I hope to explain later, why the solid prolate ellipsoid, the piece of wood, or the hard-boiled egg, sets itself on end when it is spun about one of the shortest diameters; it is not at all easy to show why the raw egg does not.

I shall now say something of Lord Kelvin's papers and work on gyrostatics, taking the various topics more or less in chronological order.

II.—*Dynamical Theory of Rotation of Plane of Polarised Light.*

The first paper in which Lord Kelvin dealt with what may be regarded as a gyrostatic problem is that published by him in the Proceedings of the Royal Society,[2] entitled "Dynamical Illustrations of the Magnetic and the Heliçoidal Rotatory Effects of Transparent Bodies in Polarised Light." He does not in that paper use the term "gyrostat" or "gyroscope," but the equations which are arrived at in the discussion of the dynamical illustrations referred to are in form essentially of the kind which he afterwards called gyrostatic.

The fundamental idea of this paper is one which he developed a good deal in later papers and, from time to time, in his lectures to his students. It is that the rotation of the plane of polarised light transmitted through a solution of sugar or tartaric acid, or across a plate of quartz cut at right angles to the axis of the crystal, is to be explained by a helical structure of the medium; while what appears at first sight to be the exactly similar rotation of that plane, by passage of the light through a piece of heavy glass along the lines of force of a magnetic field, is due to rotational motion already existing in the medium and compounded with the motion produced by the wave of light.

Think (as I heard him once say) of a transparent elastic medium full of little helical hollows of the order of 1/40,000 in. in dimensions, having all their axes turned the same way, so that to an observer looking along them the helices are all right-handed or all left-handed, or at least are preponderatingly in one direction or the other. Such a medium would have the property of transmitting, in the direction of the axes of the helices, waves of torsional displacement at different speeds according as the torsion is right-handed or left-handed.

On the other hand, let us think of a transparent elastic medium in which are embedded in a homogeneous manner innumerable particles describing circular orbits, all of which, or a majority of which, face the same way, and are traversed by the particles in the same direction round. Now let a wave of turning motion of the medium be propagated in one direction or the other, parallel to the axes of the circles. A wave-motion of a certain rapidity in one direction round, say that of the motion of the particles in the circular orbits, will call for the same centreward force, applied to the particles by the medium, as a motion of greater rapidity applied in the contrary direction round. Thus oppositely directed circular motions will, for the same displacements of the medium, have different rapidities of turning (in planes perpendicular to the direction of propagation of the wave); the corresponding waves will travel at different rates, and one will gain on the other.

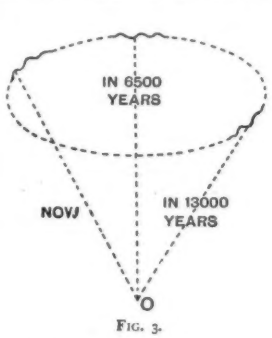


FIG. 3.

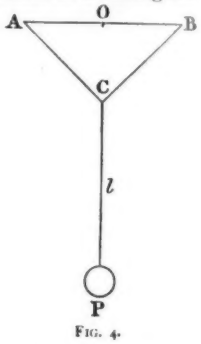


FIG. 4.

The illustration proposed was a double pendulum. A cord (see Fig. 4) is attached at the two ends of a horizontal rod A B, and to the middle point of this cord is fastened a simple pendulum, of length l as indicated. The distance of the bob from the rod is l', that is $l+OC$. The rod is made to turn with uniform angular speed ω about a vertical axis through its middle point O. The cords are supposed to be of negligible mass and quite flexible, and the bob is a massive particle.

[2] Proceedings of the Royal Society, vol. viii, p. 150, 1856.

If ω were zero we should have a pendulum the period of which is $2\pi\sqrt{l/g}$ for vibrations in the plane of the paper supposed vertical, and $2\pi\sqrt{l'/g}$ for vibrations at right angles to that plane; and the motion of the bob in the most general form would be compounded of two such oscillatory motions.

When the motion, with ω not zero, is referred to two rectangular horizontal axes of x and y through O, which revolve with the rod, the equations of motion of the bob are

$$\ddot{x} - 2\omega\dot{y} + \left(\frac{g}{l} - \omega^2\right)x = 0,$$

$$\ddot{y} + 2\omega\dot{x} + \left(\frac{g}{l'} - \omega^2\right)y = 0,$$

where x, y are the co-ordinates of the bob and $\dot{x}$, $\dot{y}$ their time rates of change, and $\ddot{x}$, $\ddot{y}$ are the accelerations corresponding.

The second terms on the left-hand sides of these equations, $-2\omega\dot{x}$, $2\omega y$, are in form what were called afterwards by Lord Kelvin gyrostatic terms, and the conditions for the existence of real periods of oscillatory motion in the general case, depending, as the reality of these periods does, on the value of ω, gives us an idea of what he termed in that connection "gyrostatic domination."

In an Appendix to this lecture (see *Journal*, I.E.E.) will be found a synopsis of the solution of this interesting case of motion with some modifications of notation and mode of presentment. The reader may refer also to the original paper.[3]. It is reprinted as Appendix F of Lord Kelvin's "Baltimore Lectures."

The main results may be expressed as follows :—

(1) If a long straight rod, which is unequally elastic in two rectangular directions, or is of unequal diameters in these directions, if of uniform elastic quality (a rod of elliptic section, for example), be rotated rapidly about its axis, and vibrations be maintained in a fixed transverse direction at one end, waves of rectilinear vibration, the direction of which slowly turns round as the wave advances, will be propagated along the rod.

(2) Let the transverse elasticity of the medium (which, to fix the ideas, may be taken, as has already been suggested, as a long straight rod, along which waves of transverse displacement are propagated in the direction of its length) vary with the direction of the transverse, so that it has maximum and minimum values in axial planes at right angles to one another. If this rod be slightly and uniformly twisted about its axis, these planes become heliçoidal or screw surfaces. Think now of a line in space parallel to the axis of the rod. This line will intersect either of these surfaces at points the successive distances apart of which are all equal to the step s of the screw. If the rod be turned about its axis as a whole, each point of intersection will move along the line at a speed v which depends on the rate of turning.

Let a rectilinear vibration be kept applied at any cross-section, say one end, and let the rod be rotated about its axis in the proper direction, and at such a rate that the speed v just specified is equal to the velocity of propagation of the wave produced by the applied vibration. The result will be that a series of waves of rectilinear vibration will run along the rod, without any turning of the plane of vibration in space. In order that the rotation may be rapid, it is necessary that the wave-length, a say, should be many times the step s of the screw.

According to our notation the period of vibration is $2\pi/\mu$, and therefore the velocity of propagation of the waves is $a\mu/2\pi$. But if s be the step of the screw, and ω denote as before the angular speed of rotation, the value of v is $\omega s/2\pi$. Hence we must have $\omega s = a\mu$ or $\omega = a\mu/s$.

The effects of the twist and rotation thus exactly balance one another. The latter (see Appendix) gives a rotation of amount $\frac{1}{4}\pi\lambda^4/\omega^3\mu$ in a wave-length, or a complete turn in $8\mu\omega^3/\lambda^4$ wave-lengths. Hence the effect of a single turn of twist in a length s is equivalent to that of rotation in $8\mu\omega^3/\lambda^4$ wave-lengths.

The dynamical illustration is thus applicable to all the cases of turning of the plane of polarisation of light. There is one point of difference, however, which renders a rotational medium more truly representative of the magneto-optic turning, and is decisive as between a rotational and a structural explanation of the different phenomena. A beam of plane polarised light which has traversed a piece of heavy glass in a magnetic field will, if it be reflected and sent back through the medium, have the turning of the plane doubled by the backward passage, while backward passage through quartz or a sugar solution annuls the turning produced by the forward passage. These facts point, as Lord Kelvin repeatedly urged in his teaching, to a rotational explanation of the magneto-optic effect and to a structural explanation for the other.

III.—*Precessional Motion of a Liquid.*

About twenty years later gyrostatic problems attracted Lord Kelvin's attention in a very special way. From 1875 onward for several years he was much occupied with many things; for instance, he transacted much business connected with submarine cable instruments, eclipsing lights for lighthouses, and compasses and sounding machines. I was one of his assistants, and remember how busy we all were. For the two years from 1875 to 1877 there are set down in the list of his papers four on the subject of gyrostatic action, but of these only two were ever printed, the first and the last. The former was entitled "Vibrations and Waves in a Stretched Uniform Chain of Symmetrical Gyrostats,"[4] the latter "On the Precessional Motion of a Liquid."[5] I shall first give some account of the latter paper, because it contained descriptions and illustrations of gyrostats and gyrostatic action, and shall then return to the former.

The circumstances in which this paper was written were interesting. In 1875 Lord Kelvin (then Sir William Thomson) visited America as one of the judges of Group 25 (Scientific Instruments) of the Centennial Exhibition at Philadelphia. He then met and conferred on scientific questions with some of the most eminent natural philosophers of the United States.

A conversation with Simon Newcomb, in Joseph Henry's drawing-room in the Smithsonian Institution at Washington, led him to doubt the legitimacy of some of his own conclusions regarding the effect of elastic yielding of the crust on the precession and nutation of a liquid earth contained within a solid shell. These conclusions were stated in his paper on the rigidity of the earth,[6] and in §§ 847-8 of the first edition of Thomson and Tait's "Natural Philosophy." For example, he had decided that the yielding of the crust of an internally liquid earth, under the differential attractions of the sun and moon, would produce an effect on the precession so great as to be altogether incompatible with the excellent agreement

[3] *Loc. cit.* above.

[4] Proceedings of the London Mathematical Society, vol. vi., p. 190, 1875; Math. and Phys. Papers, vol. iv., p. 533.

[5] British Association Report, 1876, Transactions of Sections, p. 1.

[6] Philosophical Transactions of the Royal Society, vol. cliii., p. 573, 1863.

between theory (on the hypothesis of a solid earth) and observation, as regards precession and nutation.

Newcomb appears to have suggested that viscosity might possibly render precession and nutation the same as if the earth were rigid throughout. As a direct cause viscosity is inadmissible, but indirectly it is effective, for it at once occurred to Lord Kelvin that a very real cause of agreement between an internally liquid earth and a solid earth as regards precession at least, was probably to be found in the rigidity induced in the interior liquid by its rotation. Thus his attention was directed to the quasi-rigidity of a liquid induced by rotational (or vortex) motion, a subject which, as he told Section A of the British Association after his return from America, occupied his thoughts for weeks almost to the exclusion of all other scientific subjects.

He soon found that if the ellipticity is not too small the shell would not have more precession than the liquid, and that the compound rotating mass would have sensibly the same precessional motion as if it were a single rigid body. He came to the conclusion, however, that the lunar semi-annual and lunar fortnightly nutations would be greatly affected by interior liquidity of the earth.

At the Glasgow meeting of the British Association in 1876 Lord Kelvin was president of Section A, and began his presidential address by quoting the Anacreontic couplet:—

"Θέλω λέγειν Ἀτρείδας,
Θέλω δὲ Κάδμον ᾄδειν"

which begins the complaint of the poet that no matter what hero he wished to sing, his lyre refused to respond to any theme but that of love. Try as Lord Kelvin liked to speak of the scientific men, and scientific inventions that he saw in America, of American education, or the more recent advances of physical science, his thoughts ever came back to the subject of the internal rigidity of the earth and the difficult questions therewith connected. So to this topic he decided to devote the major part of his address. This he did with great effect, clearing away what was doubtful from his former arguments, emphasising and enforcing them as they remained, and reiterating with undiminished confidence his old conclusions.

To illustrate the precession of a rotating liquid he showed later in Section A what he called a liquid gyrostat, and also for comparison various solid gyrostats which had for several years been used for the dynamical illustrations of the natural philosophy class. I have these very gyrostats here on the table, and will use them for a repetition of some of the old historical experiments of the Glasgow class-room.

IV.—*Solid and Liquid Gyrostats. Gyrostatic Experiments.*

The construction of a solid gyrostat is shown in the diagrams before you, which were made, partly by myself, nearly forty years ago (Fig. 5). The instrument consists of a massive flywheel surrounded by a case of brass. The wheel is a disc of thick brass carrying a massive rim, so that the moment of inertia is made as great as possible. One diagram of this slide, as you see, shows a section of the wheel and case, the other a side view of the wheel.

The case is a cylindrical box surrounding the flywheel, with extensions enclosing the axle, for which they are provided with bearings at the ends. Round the case, as nearly as may be in the central plane of the flywheel, is a projecting rim, the edge of which is not quite circular, but rather polygonal with curved sides, and the points of meeting of the sides rounded off. The rim serves to support the gyrostat, as it stands on this glass plate, in some of its evolutions.

The bearings are cups in which the rounded points of hardened steel of the axle run. This is not a good arrangement if the gyrostat is to be subjected to shocks, or to be roughly handled in any way. Oiling also is required, after every second spin at least. In our new gyrostats we use ball bearings designed to resist considerable shocks and stresses without derangement. With these, in some experiments, we have gone up to speeds of about 25,000 r.p.m., and have found the flywheel to be still rotating rapidly after the lapse of forty-five minutes. Also the wheel may be run for several hours with only one oiling.

It will be convenient to show here some of the experiments usually performed in the ordinary class of natural philosophy in Lord Kelvin's time. The multiplicity of subjects put down to be treated in the dynamical part of the course precluded, as I have hinted, any detailed explanations of these experiments. They were carried out, in fact, with the avowed and excellent purpose of exciting curiosity in the minds of the students, and a desire to find out why gyrostats behave in a manner at first sight so anomalous. Interest was certainly aroused in a few, but I fear that the majority despaired of penetrating such mysteries, and sought external help for the mastering of the more hackneyed topics of the degree examinations.

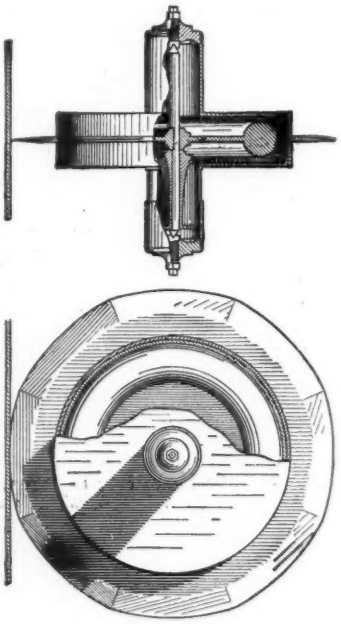


FIG. 5.

The process of spinning excited more interest than any other part of the experiment, for the ordinary elementary student cares more for a little bit of sensation than about the scientific result to be proved. A long cord was laid out on the floor, then the free end passed one and a half, or two and a half, times round the axle of the gyrostat, which was held by the operator, with its axis vertical, in a suitable socket on a table fixed to the floor. An attendant holding the free end ran away with it, slowly at first, then faster and faster, down a long passage and through a large adjoining room, while friction was applied to the cord as it entered the gyrostat case.

For the runner was substituted later a large wheel with grooved rim on which the cord was wound as it was drawn through the gyrostat. I estimate that speeds of about 100 turns per sec. or less may have been obtained in this way. Now, of course, one spins by an electric motor, as I shall presently describe.

I will make one or two of the experiments with the original gyrostats, but it will save time if I repeat the others with some of the new and improved gyrostats invented by Dr. J. G. Gray, whom I am fortunate in having to assist me on the present occasion.

[The usual experiments, illustrating precessional motion of a gyrostat with the axis horizontal, while under the influence of a couple due to the gyrostat overhanging, or to a weight hung on one end of the case surrounding the axle (Fig. 6) were performed.]

This behaviour of the gyrostat is often considered paradoxical, and must, I suppose, be regarded as difficult to explain in a popular manner. At any rate, the popular explanations are as a rule extremely unsatisfactory. Yet in this particular case of horizontality of the axis the matter is simple enough, I think. Let me illustrate by means of this pedestal top (Fig. 7). The curved arrowhead shows the direction of rotation, the projecting arrow the axis of spin, the arrow pointing down can be turned so as to show the direction of the axis of any applied couple. First observe that when I try to retard the precessional motion the axis descends, if I try to accelerate the precession the axis rises. This experiment shows that the horizontality of the axis depends

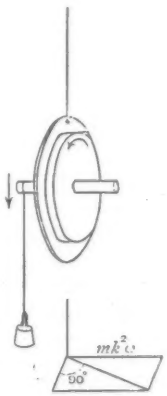


FIG. 6.

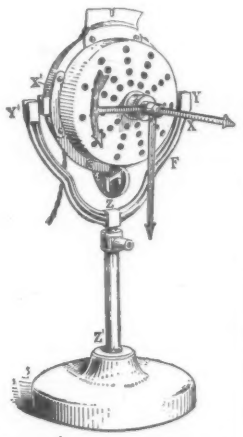


FIG. 7.—Motor-Gyrostat in "Fork and Pedestal" Mounting.

on the freedom of the gyrostat to precess at a certain definite rate. This rate, as we shall see presently, depends on the couple applied by the weight of the gyrostat acting downward in one vertical line, and the pull of the string acting upward in another line nearly vertical, and on the angular momentum of the flywheel.

Look at the thing in this way. The axis of rotation round which the flywheel has angular momentum is turning as you see towards the horizontal axis A of the couple, with angular speed, Ω say. Now, and this is the point not recognised as a rule, this motion itself creates a rate of production of angular momentum about the axis A of the couple. For when an axis with which is associated a directed quantity, L say, is turning towards a fixed direction at right angles to it with angular speed Ω, there is a time-rate of production of the quantity associated with the latter direction measured by the product $L\Omega$.

Now the flywheel is revolving with angular speed ω, so that if its moment of inertia is $m k^2$, it has angular momentum $m k^2\omega$ about the axis R; but with angular speed Ω the axis R is turning towards the instantaneous position of the axis A, a fixed direction to which R is at the moment perpendicular, and, in consequence of this turning, a rate of production of angular momentum $m k^2\omega . \Omega$ exists about A.

Now for the steady motion of the gyrostat, that is, steady turning in azimuth without rising or falling of the axis, it is only necessary that this rate should be equal to the moment of the couple about A, G let us say. Thus we get $m k^2\omega\,\Omega = G$, which gives $\Omega = G/m k^2\omega$.

If I hurry the precession by giving a little impulse, and then leave the gyrostat to itself, the hurried motion, if it continued afterwards in the horizontal plane, would result in a more rapid generation of angular momentum about A than there is moment of couple to account for, and the gyrostat would begin to turn about A, in the direction to cause the angular momentum to be produced at the proper rate, that is the axis would begin to rise. In the same way an impulse towards delaying the precession would cause the axis to begin to descend. In each case the result would be a succession of alternate rises and descents; but the subject of vibrations about steady motion will be found treated in the Appendix, § (5) [see *Journal*, I.E.E.].

Here it is important to remark that there are two possible precessional motions for the same spin and the same inclination of the axis of spin to the vertical, which are given in the theory as the roots of a certain quadratic equation (see Appendix). One is great, the other small. The former to the first approximation does not depend on applied forces, the other does. Lord Kelvin called the former "adynamic," the other "precessional." But in strictness both involve the forces, and they appear as the roots of a certain equation. One of these is at once approximately realised when the wheel is spun fast, the gyrostat set on the plate at rest, and left to itself. The motion is one of small oscillation about the steady motion, which is characterised by slow precession, given very nearly, but not quite exactly, by the same formula as before. The other motion of the axis in the same cone is one of much greater precessional angular speed. The popular expositions which I have seen of gyrostatic steady motion as a rule ignore this second possible motion. It can be realised by proper means.

In strictness we must regard this second precessional motion as characteristic also of the gyrostat when its axis is horizontal, but in that case the precessional angular speed is infinite, and only the slow motion is realisable.

The rule, often stated, that hurrying a gyrostat in its precession causes tilting up of the axis, and delaying the precession causes tilting downward, is true only of the slower more usual precession. For the faster precession exactly the reverse rule holds good. This fact does not seem to be generally known, as the rule is generally stated absolutely.

It is important to notice that if the centre of gravity of the gyrostat is above the point of support, supposed on the line of the axis, the two precessional motions are in the same direction; if, on the other hand, the centre of gravity be below the point of support, the precessional motions are in opposite directions. The faster motion changes sign in passing through an infinite value, when the axis is horizontal.

By the effect of hurrying or retarding the precession was sometimes explained in our lectures the rising and falling of a top spinning on a rounded peg in contact with a rough floor along which the top can move. At first the spin is fast and the slipping is such as to produce a hurrying friction couple which causes the erection of the top. After the spin has

fallen off the slipping is the other way and a couple which produces the reverse effect results, and the top falls.

[Experiments were here made with a gyrostat on gimbals, and with a gyrostat mounted on a trapeze hung by the crossed cords of a bifilar suspension. See "Gyrostats and Gyrostatic Action," NATURE, April 10, 1913, to illustrate the stabilising by spin of a gyrostat with two freedoms, both unstable without spin.]

As I have already stated, Lord Kelvin illustrated, by what he called a "liquid gyrostat," the fact that an oblate spheroidal shell filled with water behaves as regards precession as if its contents were solid. Here is the gyrostat with which the experiment was made (Fig. 8). It resembles the ordinary gyrostat, but the case is not completely enclosed, and the spheroidal globe containing water takes the place of the flywheel: these are the only points of difference. I spin the globe in the ordinary way, and you see that in all respects the liquid gyrostat imitates the behaviour of the solid one.

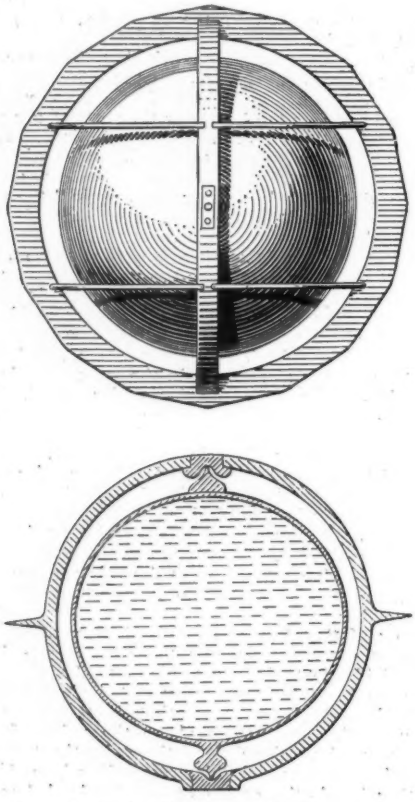


FIG. 8.—Liquid Gyrostat (Oblate).

This spheroid has an oblateness of about 5 per cent.; that is, the difference in length of the polar and equatorial diameters is about 5 per cent. of the length of either. Here, however, is another liquid gyrostat which has about 5 per cent. of prolateness (Fig. 9). I attempt to spin it, and you see that as soon as it is removed from the spinning apparatus its spin has entirely disappeared. In consequence of instability of the motion, the energy of rotation has been entirely transformed into heat, by turbulent motion of the water, into which the rotational motion breaks down. Permanent steady rotation of the liquid globe is impossible.

Oblateness, however, is not absolutely essential for steady rotational motion of a liquid round the axis of figure in a spheroidal case turning with the liquid. It was shown by Sir George Greenhill in 1880 (three years after the meeting of the British Association at Glasgow) that steady motion is possible in a prolate

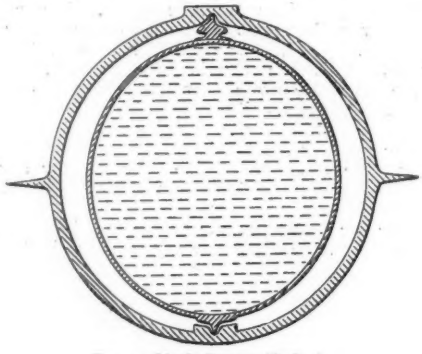


FIG. 9.—Liquid Gyrostat (Prolate).

spheroid, if it be sufficiently prolate. The axial diameter, in fact, must either be shorter than the equatorial diameter, or be more than three times as long.[7] As Sir George Greenhill points out, a modern elongated projectile if filled with a liquid would not rotate steadily about its axis of figure, and therefore would not have a definite trajectory as a rifle bullet has; it would turn broadside on to the direction of motion.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—The Society of Merchant Venturers, in whose Technical College the faculty of engineering is provided and maintained, has decided to offer ten scholarships, tenable in the faculty for three sessions, beginning with the session 1915–16, to the sons of officers in his Majesty's Service who have been killed in the war, and whose mothers or guardians are in needy circumstances.

CAMBRIDGE.—The adjudicators of the Smith's prizes and the Rayleigh prizes are of opinion that the following essays sent in by the candidates are of distinction:—H. Glauert, of Trinity College, on the elliptical form of a rotating fluid mass as disturbed by a satellite, and H. Jeffreys, of St. John's College, on (i) certain hypotheses as to the internal structure of the earth and moon, (ii) on a possible distribution of meteors, to whom the Smith's prizes have been awarded in alphabetical order. A Rayleigh prize has been awarded to J. Proudman, of Trinity College, for his papers on tidal motions.

MR. HERBERT A. L. Fisher, vice-chancellor of the University of Sheffield, has been elected a trustee of the British Museum, in succession to the Right Hon. Sir George O. Trevelyan, Bart., O.M., who has resigned on account of ill-health.

[7] Proceedings of the Cambridge Philosophical Society, 1880 Encyclopædia Britannica," article, "Hydromechanics."

PROF. ARTHUR KEITH, conservator of the museum of the Royal College of Surgeons of England, will deliver, during the latter part of March, a course of five lectures upon the bearing of recent discoveries on our conception of the evolution and antiquity of man. The lectures will be given under the terms of the Macbride Foundation in Western Reserve University, Cleveland.

THE London County Council has arranged for a series of five public lectures to be given at the Horniman Museum, Forest Hill, on Wednesday evenings at 7.30 o'clock. The series commenced yesterday with a lecture on the Andamanese and other pigmies. The subjects of the remaining lectures will be: the Australian Aborigines; the Eskimo; the Papuans of New Guinea; and the Maori and other Polynesians. Each lecture is complete in itself, and there is no charge for admission.

A LECTURESHIP in ophthalmology has been established in Dublin by the bequest of Mr. R. J. Montgomery, who desired that it should be known as the Mary Louisa Prentice Montgomery lectureship, and that the appointment to it should rest each alternative five years with the Board of Trinity College, Dublin, and with the president, vice-president, and council of the Royal College of Surgeons in Ireland. Joint regulations for the lectureship have now been drawn up, and the first election will take place at the beginning of the next summer session.

THE distribution of prizes and certificates at the Sir John Cass Technical Institute and the opening of the new metallurgy laboratory for the mechanical testing of metals and alloys, presented to the institute by the Worshipful Company of Goldsmiths, by Sir Robert G. C. Mowbray, Bart., Prime Warden of the Worshipful Company of Goldsmiths, will be held on Wednesday, March 3, at 8 p.m. The chair will be taken by Sir Thomas H. Elliott, K.C.B., chairman of the governing body. There will be an exhibition of work by students of the department of arts and crafts and by members of the Arts and Crafts Society, as well as an exhibition of students' work and apparatus in the laboratories and workshops.

A NOTE in the *Daily Chronicle* of February 24 refers to the effect of the war upon the attendance of students in the twenty-two German universities. It appears that entered on their books are 52,504 students, against 59,600 this time last year. But of these 29,882 have been "permitted" to join the military forces of the Empire, including 300 women students in the army medical department. The actual attendance at lectures is given as 18,922 men and 3700 women. If the students of technical high schools with university status are added the grand total of 38,400 is reached, or about 75 per cent. of the entire number. The universities most depleted of students are those nearest the frontiers—Bonn and Heidelberg in the west, and Königsberg and Breslau in the east. It is stated in *Science* of February 12 that there are matriculated in the University of Berlin 7037 men and 898 women, as compared with 8200 men and 859 women last winter. These numbers show a marked contrast with those of our own universities; for at Oxford and Cambridge alone the number of undergraduates now in residence is about 2300, whereas at the like period last year it was 6700.

THE Council of the London (Royal Free Hospital) School of Medicine for Women is now arranging for a considerable extension of laboratory and teaching accommodation. This extension is necessitated both by the increasing number of women desirous of entering the medical profession and by the recognition of the fact that research work must be regarded as an integral part of education, and that no medical school can be considered as satisfactorily equipped without full facilities for the carrying out of scientific investigations. A site adjoining the present buildings of the school has been secured, and the extension will include additional accommodation for teaching and much improved facilities for research work. For this very necessary extension the sum of 25,000*l.* is necessary for building and equipment, and a further similar sum for endowment. By the kindness of the Duchess of Marlborough a meeting was held at Sunderland House on February 18 to promote the extension. The speakers were the Duchess of Marlborough (in the chair), Surgeon-General Sir Alfred Keogh, Dr. Mary Scharlieb, Dr. Florence Willey, Dr. Winifred Cullis, and Mr. Acland, M.P. The Duchess of Marlborough in her speech brought out the extreme urgency of the careful use of medical service during this present crisis and the great necessity for an increased service in the future, and particularly of medical women, who were needed as medical inspectors of school children and as workers in maternity and infant welfare centres, whilst there was also a very great need amongst women for practitioners of their own sex. Sir Alfred Keogh, Director-General of the Army Medical Service, paid an eloquent tribute to the work of the school, with which he had familiarised himself when, a few years ago, he had for the Board of Education to inspect practically every medical school in the country, saying that he yielded to none in his admiration of the school. He further made the gratifying announcement that as a result of the excellent work done by medical women in the war he had offered to two medical women who had organised a hospital unit in Paris, and later one at Boulogne, a hospital of 500 beds, or, if they could staff it, of 1000 beds here in England. The other speakers emphasised the necessity there would be for medical women after the war, when prophylactic measures would be of greater importance than before, and such work as ante-natal treatment and infant care would be of even greater significance when every child would be of added value.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 18.—Sir William Crookes, president, in the chair.—Prof. W. A. **Bone** and others: Gaseous combustion at high pressures. Mixtures of methane with less than its own volume of oxygen were exploded in steel bombs at initial pressures of between 8 and 32 atmospheres. The results were in harmony with the "hydroxylation" theory of hydrocarbon combustion put forward some years ago by Prof. Bone. Results of experiments upon an equimolecular mixture of ethane and oxygen have again confirmed the hydroxylation theory. Another section of the paper deals with an experimental determination of the relative affinities of methane, hydrogen and carbon monoxide for oxygen in flames. It is shown (1) that the affinity of methane is at least twenty times as great as that of hydrogen; (2) that when mixtures corresponding to $CH_4+O_2+xH_2$ are fired under high initial pressures, in which the partial pressures of methane and oxygen are kept constant and x only varied, the distribution of oxygen between the methane and hydrogen varies with x^2—which means that hydrogen is burnt *directly* to steam in flames as the result of the tri-molecular change $2H_2+O=2H_2O$, and not (as some have supposed) *indirectly* through hydrogen peroxide. The affinity of carbon monoxide

is shown to be comparable with that of hydrogen for oxygen in flames. The final section describes experiments in which the whole pressure curves, up to and far beyond the attainment of maximum pressure, were recorded when mixtures corresponding to (1) $2H_2+O_2+4N_2$, (2) $2CO+O_2+4N_2$, and (3) $CH_4+O_2+4N_2$ are exploded under initial pressure of about 50 atmospheres. The rates of attainment of maximum pressure in each case have no direct relation to the order of affinities of the various gases for oxygen.—Prof. W. M. **Hicks**: The orbits of a charged particle round an electric and magnetic nucleus. Two problems are discussed—the orbits of α-particles and the orbits of electrons round nuclei containing mass, a definite number, n, of positive electronic charges and a definite number, N, of co-axial magnetons—the motion being in their equatorial planes. It is found that combined systems (atoms) with α-particles may exist in which the α-particle revolves in permanent connection with the nucleus, provided the internal energy of the atom is greater than a certain critical value, and that states of "radio-active" instability occur in which, after a combination of long duration, the α-particle is shot off to infinity. The exact velocity of emission in any case depends on the values of the n, N, but it is of the order of magnitude of the velocity of emission of α-rays from radium. In the case of electronic orbits, in addition to the combined systems with internal energy less than from infinity, there can exist also permanent systems in which the internal energy is greater than that from infinity, although less than a certain critical amount, and in which again states of "radio-active" instability occur of the proper order of magnitude.—**S. Chapman**: The lunar diurnal magnetic variation and its change with lunar distance. Balfour, Stewart, and Schuster have developed a theory of the solar diurnal magnetic variations which attributes them to electric currents in the upper atmosphere, impelled by electromotive forces produced by the motion of the air across the earth's permanent magnetic field. The atmospheric conductivity is supposed to be wholly or partly due to solar influence and varies with the sun's hour angle. This theory apparently applies also to the lunar diurnal magnetic variations which possess a semi-diurnal component of constant phase, together with other components the epochs of which depend on the angular distance between the moon and sun; hence, when averaged over a lunation, all components save the former disappear. The suggested solar influence on the atmospheric conductivity is thus supported, and a semi-diurnal atmospheric oscillation—such as a lunar atmospheric tide—is suggested as the source of the magnetic variations. Before this theory was developed, Brown (Trevandrum Observations, 1863) had found that the amplitude of the 12-hour magnetic component at perigee was to that at apogee in the ratio of (lunar distance)$^{-3}$ at the two epochs—"as in the tidal theory," he briefly remarked; but Figee (Batavian Observations, 1903) disputed this conclusion. The present paper discusses the evidence, of this direct kind, for or against a tidal origin of these magnetic variations. Brown's and Figee's data are used, together with much newly computed material from other observatories. The total hypothesis is confirmed, although on account of the accidental errors affecting the minute quantities under discussion, the exact law of (distance)$^{-n}$, with $n=3$, is not beyond question, but if n is assumed necessarily integral, its value is certainly 3 and not 2 or 4.—Lt.-Col. J. W. **Gifford**: Some temperature refraction coefficients of optical glass. This is a supplement to a paper read in 1912 in which the refractive indices for 13 wave-lengths of 27 different glass meltings were given by the author. To this table are now added similar indices for six more Jena glass meltings, including those for the recent fluor crown. This is followed by a table of the temperature refraction coefficients for all the glass meltings dealt with, and attention is directed to the abnormal coefficients for fluor crown which is a minus quantity. An attempt is then made to determine, if only approximately, the influence of barometric changes on the refractive powers of optical glass which would seem to be, similarly, a minus quantity, amounting to something like six units in the sixth decimal place only.

Royal Meteorological Society, February 17.—Capt. H. G. Lyons, president, in the chair.—A. E. M. **Geddes**: Observations of the upper atmosphere at Aberdeen by means of pilot balloons. These observations were made at the Observatory, King's College, Aberdeen, during the years 1912 and 1913; and in every case two theodolites were used, thus securing an accurate determination of the flights to a level of 3000 metres. In clear weather the upward velocity of the balloon is shown to be fairly uniform, but to depend on more than the free lift. When clouds are present they influence considerably this velocity, the effect differing according to the nature of the cloud. The gradient wind velocities and directions have been calculated and compared with those actually found by observation.—V. G. **Anderson**: Influence of weather conditions upon the amounts of nitric acid and of nitrous acid in the rainfall at Melbourne, Australia. The author described the methods adopted and stated that the results of the daily determinations from November 1, 1912, to February 28, 1914, when correlated with the meteorological data for Melbourne and the isobaric charts for Australia, reveal the existence of a relation between weather conditions and the amounts of the nitrogen acids in the rainfall. The concentration of nitric acid reached a maximum in summer, a minimum in winter, and an intermediate position in autumn and spring. The concentration of nitrous acid reached a maximum in winter and a minimum in summer. Nine well-defined recurring types of rainstorms have been investigated, the amounts (pounds per 1000 acres) of oxidised nitrogen per day varying from 1·5 in the case of certain antarctic storms to 35·0 in the case of intense tropical storms.

Institution of Mining and Metallurgy, February 18.—Dr. F. H. Hatch, president, in the chair.—J. **Morrow Campbell**: Notes on some gold occurrences in Ashanti. Some 30 miles to the west of Kumasi are to be found igneous rocks intruding through the schist, some of which are granite, and non-auriferous. The non-granite dykes, on the other hand, are mostly auriferous, and the author has devoted special attention to three of these in his paper. All three are comparatively old, and show abundant internal evidence of the continuance of the crustal movements to which they owe their existence. These movements have produced fracturing, and have resulted in the formation of quartz veins traversing the igneous rock in all directions, and varying in width from more than a foot to mere partings. After describing in detail the composition and characteristics of these dykes, the author draws certain deductions. He points out that in Ashanti pyrites is abundant in quartz veins, and elsewhere, quite unassociated with gold, but that where arsenopyrite occurs gold so frequently accompanies it as to lead to the conclusion that their association cannot be fortuitous. He thinks it fair to conclude that the arsenopyrite caused the precipitation of the gold, and that the solution transporting the gold contained the latter in combination

with silica either as a silicate or as alkaline auro-silicate. The phenomena, he thinks, demand a single solution from which gold and silica may be precipitated simultaneously.—W. G. **Holford**: Some features in the mining problems of the eastern Witwatersrand area. This paper is a general review of the more intricate geological problems associated with mining in the particular area referred to, where conditions are somewhat different from those met with in the central Rand. For example, while it is found on the central Rand that the close proximity of the zones in which economic gold values are contained are in such close proximity as almost to constitute defined shoots, on the eastern rand the zones are less frequent and are of greater economic value in the synclinal portions of the areas. The author goes on to describe in detail the various features of mining practice in the district under consideration, dealing respectively with mining areas, shaft sinking, initial development, the mechanical equipment, and the labour problems encountered. Incidentally he makes a strong argument in favour of circular as against rectangular shafts.—W. B. **Middleton**: Prospecting tin land in Malaya. This is a practical paper concerning itself with the alluvial deposits which are the principal source of the tin production of the Malay Peninsula. The author gives full particulars of the various methods employed in treating, prospecting, and sampling the ground, including an elaborate description of the tools required, and as an appendix he furnishes a set of tables for calculations and conversions in connection with the work, which should prove of great utility.

CAMBRIDGE.

Philosophical Society, February 8.—Dr. Barnes, vice-president, in the chair.—Sir J. J. **Thomson**: Theory of the mobility of negative ions.—Dr. G. F. C. **Searle**: (1) The determination of the focal length of a thick mirror. (2) Experiment on the focal lines formed by refraction at a plane surface. (3) Calculation of the electrical resistance of a certain network of conductors.—C. T. R. **Wilson**: A method of measuring the thickness of thin plates. The method is a modification of that of Macé de Lépinay and Buisson in which μe, the product of refractive index and thickness, is obtained by measurements of the thin-plate fringes and $(\mu-1)e$ by observing the retardation produced by the plate when inserted in the path of a beam of light.—G. W. **White**: Investigation of the "wolf-note" in bowed stringed instruments. With all stringed instruments of the violin type a pitch can be found at which it is difficult and often impossible to obtain a pure steady tone. In the preliminary experiments to investigate this imperfect note photographs were obtained of the belly vibration of a 'cello by reflecting a beam of light from an optical lever to a moving photographic plate. A series of notes through the "wolf-note" played with a constant bow pressure was studied. At the "wolf-note" the vibration curve had an extremely big amplitude and showed that the unsteady nature of the tone was due to a "beating" of the instrument belly. The experiments proved conclusively that the "wolf-note" was caused by the impressed string pitch coinciding with the pitch of best resonance of the instrument.

MANCHESTER.

Literary and Philosophical Society, January 26.—Mr. F. Nicholson, president, in the chair. W. C. **Jenkins**: Manchester fogs of the last ten years. A comparison of the fogs in Manchester during 1904–1913 inclusive showed that the number of days affected by this phenomenon has increased during the latter years by at least 30 per cent. as compared with the earlier years of this period. By a rearrangement of the figures into seasonal effects the most striking feature is the increase of days classified as "gloomy" during the summer months, the number during the winter months of October to March remaining fairly constant. The number of days affected by "gloom" increased 100 per cent. during the period of the last four years as compared with the number so classified in the first four years of the period under consideration. These fog glooms are situated close to the earth's surface, as is shown by a comparison of sunshine records taken from the roof of the School of Technology and on the ground, the hours of sunshine measured on the ground being approximately 10 per cent. less than the amount recorded from the roof (100 feet higher).—Prof. W. W. Haldane **Gee**: Note on the monthly variation of sunshine. As a result of his examination of the Campbell-Stokes records, the author found that the average percentage of the possible sunshine usually reaches a maximum in May. A number of examples of this law were quoted. It was true for Glasgow, Douglas (I. of M.), Llandudno and Stonyhurst, 1880–1885; for St. Aubins (Jersey), 1880–1885; Blackpool, 1882–1885; Buxton, 1881–1885; Durham, 1880–1884; and for the Godlee Observatory (Manchester School of Technology), 1906–1910. The records for Stonyhurst for the thirty-three years from 1880–1912 also show the maximum in May. For 1910, Manchester (Oldham Road), Manchester (Whitworth Park), Buxton, Blackpool, and Llandudno also show the maximum in May. The author thought that the sunlight in May must have an important influence on vegetable growth.—W. C. **Jenkins**: Weather repetitions, with suggestions for long-distance forecast. Attention was directed to the repetitions in the weather for periods of twelve hours, twenty-four hours, seven days, and the lunar month, and also annual repetitions, making certain allowances—using particularly the records of rainfall. With the view of establishing these repetitions to a definite origin, the author showed the connection between numerous cyclonic paths and extra terrestrial phenomena, and assuming similar forces acting in temperate latitudes, he proceeded to demonstrate that cyclonic movements in the regions of this kingdom followed very much the variations expected under these conditions.

BOOKS RECEIVED.

Breeding of Farm Animals. By Prof. M. W. Harper. Pp. xvii+335. (New York: Orange Judd Co.; London: Kegan Paul and Co., Ltd.) 1.50 dollars.

Practical Physical Chemistry. By Prof. A. Findlay. Third edition. Pp. xvi+327. (London: Longmans and Co.) 4*s.* 6*d.* net.

A Summer on the Yenesei (1914). By M. D. Haviland. Pp. xi+328. (London: E. Arnold.) 10*s.* 6*d.* net.

Board of Education. Examinations in Science and Technology, 1914. Examination Papers and Reports of Examiners. Pp. 142. (London: H.M.S.O.; Wyman and Sons, Ltd.) 9*d.*

Alone in the Sleeping Sickness Country. By Dr. F. Oswald. Pp. xii+219. (London: Kegan Paul and Co., Ltd.) 8*s.* 6*d.* net.

Arabia Infelix, or, the Turks in Yamen. By G. W. Bury. Pp. x+213. (London: Macmillan and Co., Ltd.) 7*s.* 6*d.* net.

The Chemistry of Petroleum and its Substitutes. By Drs. C. K. Tinkler and F. Challenger. Pp. xvi+352. (London: Crosby Lockwood and Son.) 10*s.* 6*d.* net.

Journal Kept by David Douglas during his Travels in North America, 1823–1827, etc., with appendices containing a List of the Plants introduced by Douglas, and an account of his death in 1834. Pp. 364. (London: W. Wesley and Son.) 21s. net.

Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1913. Pp. 417. (Ottawa: J. de L. Tache.)

Icones of the Plants of Formosa, and Materials for a Flora of the Island. By B. Hayata. Vol. iv. Pp. vi+264+plates xxxv. (Taihoku: Government of Formosa.)

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology, vol. ii., No. 2, Oligochaeta. By H. A. Baylis. Pp. 13–18. Zoology, vol. ii., No. 3, Parasitic Worms, with a Note on a Free-living Nematode. By Dr. R. T. Leiper and Surgeon E. L. Atkinson. Pp. 19–60. (London: British Museum (Natural History); Longmans and Co.) 1s. and 1s. 6d. respectively.

The Chemistry of Colloids and some Technical Applications. By Dr. W. W. Taylor. Pp. viii+328. (London: E. Arnold.) 7s. 6d. net.

Forest Valuation. By Prof. H. H. Chapman. Pp. xvi+310. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8s. 6d. net.

X rays and Crystal Structure. By Prof. W. H. Bragg and W. L. Bragg. Pp. vii+228. (London: G. Bell and Sons, Ltd.) 7s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 25.

ROYAL SOCIETY, at 4.30.—The Effect of the Depth of Pulmonary Ventilation on the Oxygen in the Venous Blood of Man: Prof. L. Hill and J. F. Twort.—The Effect of Functional Activity upon the Metabolism, Blood Flow and Exudation in Organs: J. Barcroft and Toyojiro Kato.—The Osmotic Balance of Skeletal Muscle: Miss D. Jordan Lloyd and W. B. Hardy.—The Function of Chlorophyll: Dr. A. J. Ewart.—Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera: E. Heron-Allen.—The Influence of the Hydrogen Concentration upon the Optimum Temperature of a Ferment: A. Compton.

ROYAL INSTITUTION, at 3.—Struggle of Nations: Dr. P. Chalmers Mitchell.

CHILD STUDY SOCIETY, at 6.—*Discussion*: The Care and Development of the Child—from Ante-Natal Period to Five Years of Age. Ante-Natal Period: Dr. G. Eric Pritchard; Infancy: Miss J. Halford; One to Five Years: Dr. D. Forsyth.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electricity applied to Mining: C. P. Sparks.

FRIDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 9.—Solar Eclipse of 1914: The Rev. A. L. Cortie.

PHYSICAL SOCIETY, at 5.—Magnetic "Character" Figures. Antarctic and International: Dr. C. Chree.—The Electrification of Surfaces as Affected by Heat: Dr. P. E. Shaw.—Electromagnetic Inertia and Atomic Weight: Prof. J. W. Nicholson.

SATURDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Incisor-teeth of Rhinoceros: E. T. Newton.—Palæolithic Implements and Plant Seeds from the River Gravel at Hackney Wick in the Lea Valley: A. Wrigley.—The New Witches-Broom on the Crack Willow: Miller Christy.—East Anglian Gravels: W. H. Dalton.

MONDAY, MARCH 1.

SOCIETY OF CHEMICAL INDUSTRY, at 8.

ARISTOTELIAN SOCIETY, at 8.—The Æsthetic of Benedetto Croce: A. A. Cock.

VICTORIA INSTITUTE, at 4.30.—The Spectra of Stars and Nebulæ: Prof. A. Fowler.

ROYAL SOCIETY OF ARTS, at 8.—Motor Fuels: Prof. Vivian B. Lewes.

SOCIETY OF ENGINEERS, at 7.30.—Running Costs of Motor Vehicles: Lieut. R. W. A. Brewer.

TUESDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—Photographic Appreciation of Colour in Monochrome: Prof. W. J. Pope.

ROYAL SOCIETY OF ARTS, at 4.30.—The Northern Territory of Australia: Past, Present, and Future: D. Lindsay.

RÖNTGEN SOCIETY, at 8.15.—The Chemistry of the Radio Elements: A. Fleck.

WEDNESDAY, MARCH 3.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Soluble Chlorides and Total Chlorine in some English Cokes: S. W. Bridge.—The Routine Detection and Estimation of Boric Acid in Butter: H. Hawley.—The Structure of Pepper—Some New Features: T. E. Wallis.—The Occurrence of Chlorine in Coal: A. de Waele.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section), at 7.45.—The Application of Electrical Engineering to Warfare—Communications, Wireless, etc.: P. R. Coursey; The Laying and Firing of Mines: S. G. Killingback; Searchlights and Projectors: E. L. M. Emtage.

ROYAL SOCIETY OF ARTS, at 4.30.—Shakespeare's Profession: W. Poel.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MARCH 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: A Bolometric Method of Determining the Efficiency of Radiating Bodies: Prof. W. A. Bone, Prof. H. L. Callendar, and H. J. Yates.—The Simplification of the Arithmetical Processes of Involution and Evolution: E. Chappell.—The Elastic Properties of Steel at Moderately High Temperatures: F. E. Rowett.

ROYAL INSTITUTION, at 3.—Poetry and War: Sir Herbert Warren.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Suess's Classification of the Eurasian Mountains: Prof. J. W. Gregory.

FRIDAY, MARCH 5.

ROYAL INSTITUTION, at 9.—Mimicry and Butterflies: Prof. E. B. Poulton.

GEOLOGISTS' ASSOCIATION, at 8.—Geology of the Glasgow District: Prof. J. W. Gregory.

SATURDAY, MARCH 6.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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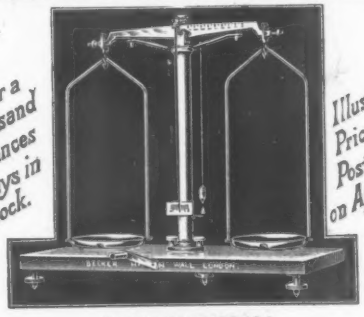

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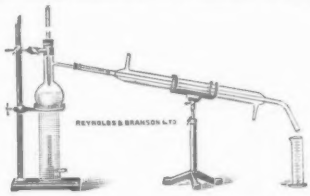

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Attention is directed to the following topical articles which have appeared in NATURE:—"Openings for British Chemical Manufacturers" (*September 17*); "Glass for Optical Purposes" (*October 1*); "The Cultivation of Medicinal Plants in England" (*October 15*); "The Sea Fisheries and the War" (*October 22*); "Science and the State" (*October 29*); "Potassium Salts and Agriculture" (*November 12*); "The Supply of Pitwood" and "Effects of the War on Scientific Undertakings" (*December 10*); "High Explosives in Warfare" (*December 24*); "Optical Glass and Scientific Instruments: United Kingdom Imports and German Exports" (*January 7*); "The Manufacture of Dyestuffs in Britain: a Summary and an Appeal" (*January 21*); "Synthetic Drugs in Great Britain" (*January 28*); "Trinitrotoluene in the War" (*February 4*); "The Manufacture of Dyestuffs" (*February 11*); "Chemistry and Industry" (*February 18*). Any one number will be sent by post on receipt of its published price, plus postage.

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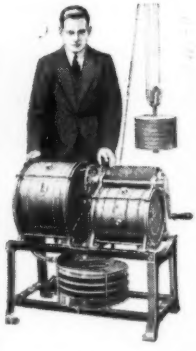

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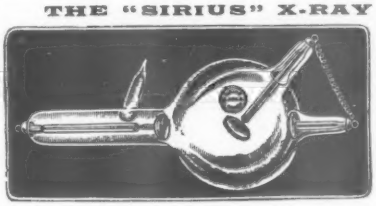

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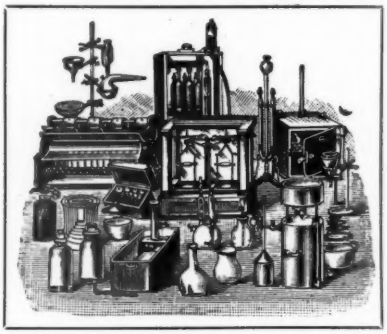

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